THE

JOURNAL

OF

GAS LIGHTING,

WATER SUPPLY,

AND

SANITARY IMPROVEMENT.

88062

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WILLIAM B. KING,

11, BOLT COURT, FLEET STREET, E.C.

THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

[REGISTERED AS A NEWSPAPER.]

VOL. XXXI. No. 764.] LONDON, JANUARY 1, 1878. [30TH YEAR.] Price 6d.

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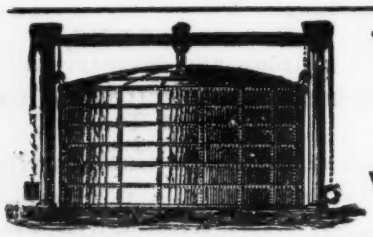

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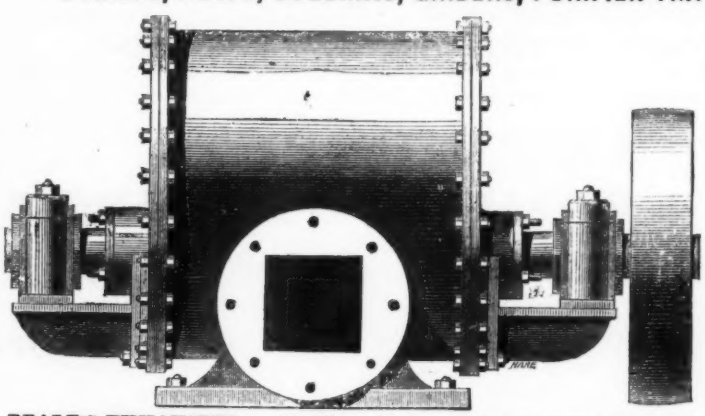

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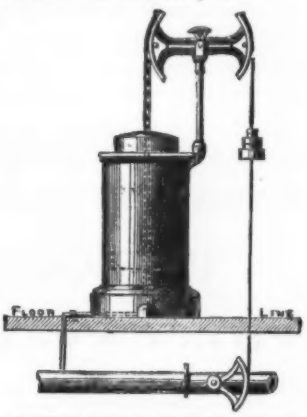
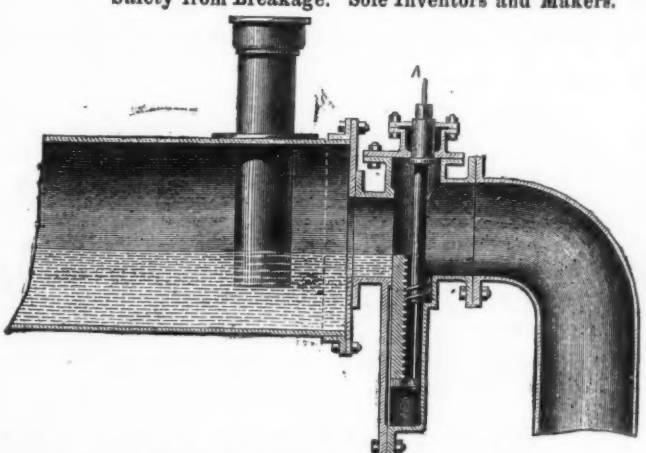


HYDRAULIC REGULATOR.



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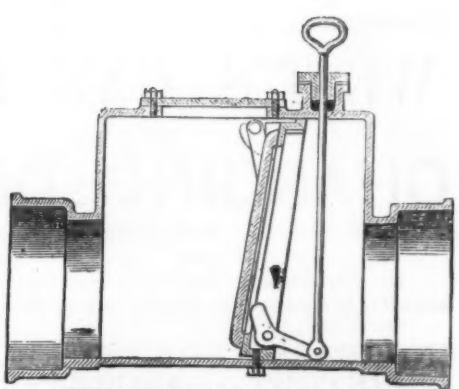

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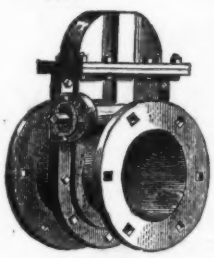

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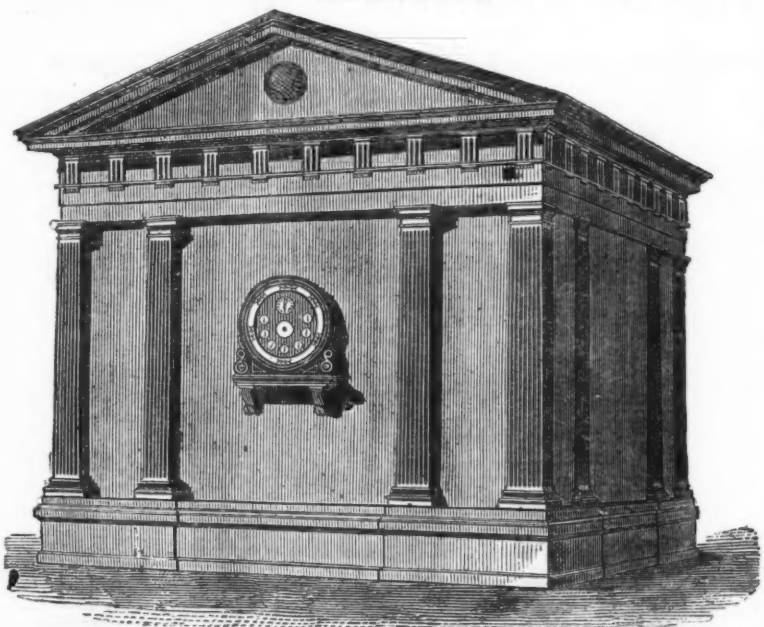

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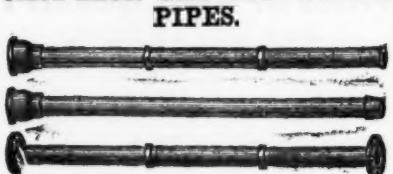

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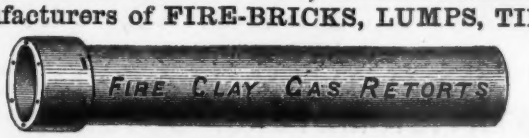

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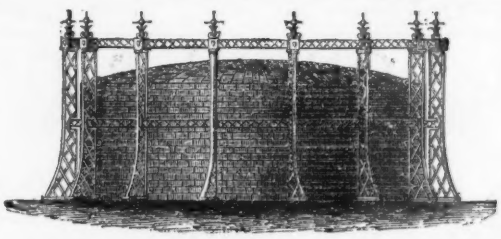

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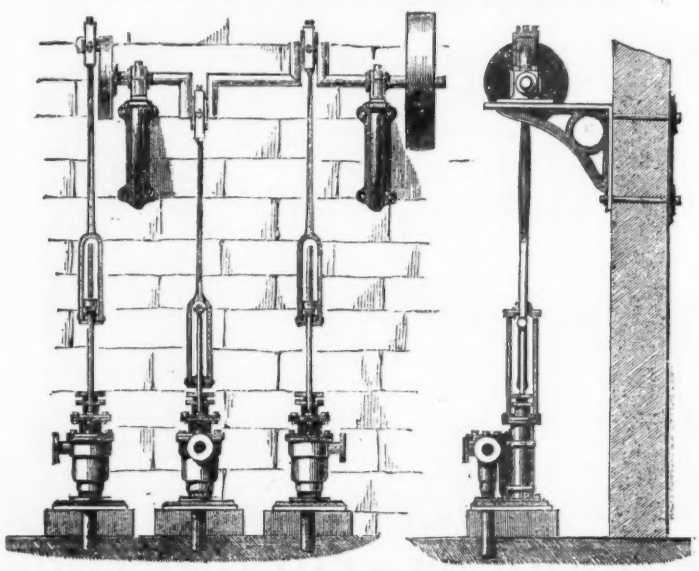

IMPROVED DOUBLE-ACTION PUMPS.
For Water. For Tar. For Ammoniacal Liquor.
This illustration shows an arrangement of three (No. 179) Improved Double-Action Pumps driven from the same crank-shaft, as frequently supplied for use in Gas and Chemical Works. The suction and discharge pipes can be arranged for drawing from and delivering in any required direction.
These Pumps have been supplied to nearly all the large Gas Companies and Chemical Works, both for Pumping Water, Tar, and Ammoniacal Liquor.
GAS SYPHON PUMPS, IN COPPER OR SHEET IRON, ALWAYS IN STOCK.
Illustrated Catalogues sent post free on application.

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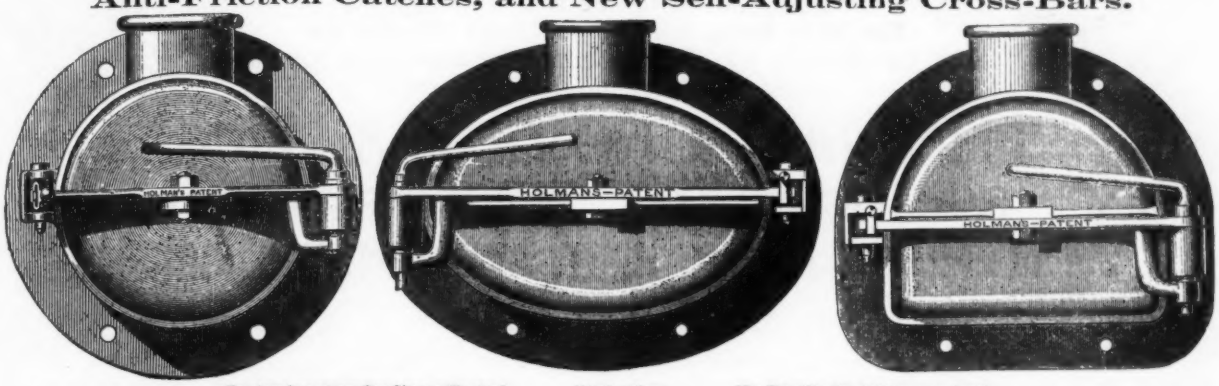
SOLE MAKERS OF MORTON'S PATENT SELF-SEALING RETORT-LIDS,

WITH HOLMAN'S PATENT ECCENTRIC FASTENINGS,

Anti-Friction Catches, and New Self-Adjusting Cross-Bars.



Instantaneous Sealing effected. No Luting. No Duplicate Lids required.

Holman's New Self-Sustaining Cross-Bar ensures freedom of Joint, and maintains parallel position of the Lids.

Since their introduction in 1869, these Patent Retort-Lids have been thoroughly tested, being now in use in nearly all the principal Gas-Works in London and the Provinces.

T. B. and H. are now making the "Morton's Self-Sealing Lid" of the SAME FORM OR SECTION AS THE RETORT (see Illustrations above), as well as bringing the Mouthpiece from the D or Oval at back to Circular in front, as heretofore.

D and Oval Morton's Lids are working satisfactorily both in this country, on the Continent, and in the United States of America. Among others they have been adopted by the following Gas-Works:—

The Gaslight Company's Works, Fulham; Ditto, Bromley-by-Bow; Ditto, King's Cross; Ditto, Shoreditch.
And also in the Gas-Works at Richmond, Maidstone, Gloucester, Glasgow, Portsea, Roubaix (France), The Hague (Holland).

HUNT'S PATENT EQUILIBRIUM GAS-GOVERNOR.

In this Governor a Throttle-Valve is substituted for the ordinary suspended Cone, all external communications being avoided by placing the Lever or Radius Arm (shown in the drawing) inside the Valve-Chamber upon the Disc. The Disc is carried upon steel centres, upon which it is accurately balanced and turns freely. The friction in working is thereby reduced to a minimum. This Governor is extremely sensitive to alterations of inlet or outlet pressure, and renders a large actuating holder unnecessary.

The principal advantages of this arrangement over the ordinary form of Governor are as follows:—

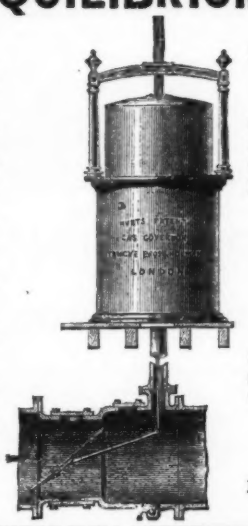
Its sensitive action prevents oscillation.

It is self-adjusting—*i.e.*, it maintains a steady pressure under variations of inlet pressure or a fluctuating consumption.

The inlet to Gasholder being contracted to the smallest possible dimensions, all danger from leakage through insufficiency of seal, tilting, &c., is entirely avoided.

The valve portion being separate from the holder, it can be handled and fixed like an ordinary Slide-Valve direct in the main; and the holder can be placed at any convenient distance immediately above it. The cost is thus materially reduced, and the inconvenience of heavy lifts done away with.

There are no working parts likely to get out of order.



These Governors have been adopted by many leading Gas Companies, among whom are the following:—

The Gaslight and Coke Co. (9), The London Gas Co. (3), and at Abergavenny, Arundel, Birmingham, Cannes (France), Devonport, Dursley, Exeter, Guernsey, Halesowen, Mentone (France), Monmouth, Newcastle-on-Tyne, Oxford, Plymouth, Rochdale, Windsor, &c.

TESTIMONIAL.

The Gaslight and Coke Company,
9, Water Street, New Bridge Street,
Blackfriars, E.C., Feb. 27, 1875.

MESSRS. TANGYE BROTHERS AND HOLMAN.

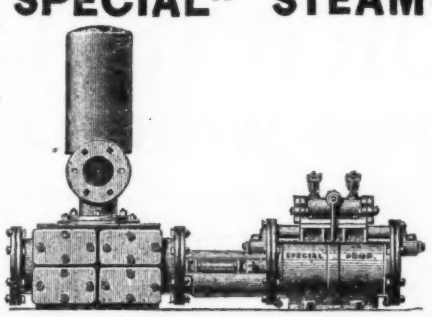
Gentlemen,—The two 24-inch and three 36-inch Hunt's Equilibrium Governors supplied by you, and fixed in the valve-rooms at Whitechapel, Goswell Road, and Blackfriars, are working very satisfactorily.

Yours truly,
(Signed) JOHN JOHNSON.

PRICES AND FULL PARTICULARS ON APPLICATION.

THE "SPECIAL" STEAM-PUMP.

Diameter of Steam Cylinder.	Diameter of Water Cylinder.	Length of Stroke.	Gallons of Water per Hour, Approximate.	Reduced Prices.
3	1½	9	450	£16
4	2	9	815	18
5*	2½	12	1,250*	20
5*	3	12	1,830*	22 10
4	4	12	3,250	25
6*	4	12	3,250*	30
5	5	12	5,070	32 10
7*	5	12	5,070*	40
6	6	12	7,330	40
8*	6	12	7,350*	50
7	7	12	9,750	50
10*	7	12	9,750*	65



In use in a Hundred Gas-Works in the United Kingdom for Pumping Ammoniacal Liquor, Water, or Tar.

Messrs. Burt, Boulton, and Haywood, Manufacturing Chemists, have over FORTY "Special" Steam-Pumps in use at their several large Tar-Works.

Two Hundred Sizes made. Those in Table opposite are the leading Sizes for use in Gas-Works and Chemical Works.

* These Sizes being usually selected for pumping Tar and Liquor, are always in stock, or nearly ready, fitted with all pump details in iron, and extra length distance-piece between steam and pump cylinder, at a small extra cost.

TANGYE'S HIGH-PRESSURE AND CONDENSING STEAM-ENGINES; CORNISH, VERTICAL, & TUBULAR BOILERS; HYDRAULIC AND SCREW LIFTING-JACKS, CRABS, PULLEY-BLOCKS, &c.

FULL PARTICULARS, ESTIMATES, CATALOGUES, ETC., ON APPLICATION.

London, 1851 New York, 1853. Paris, 1855. London, 1862.

Dublin, 1865.

The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

LONDON, E.C.

THOMAS GLOVER & CO.'S PATENT DRY GAS-METERS

1st, Are a remedy for all the defects of Wet Meters;
2nd, Are suitable for all climates, whether hot or cold;
3rd, Incur no loss of Gas by evaporation;
4th, Cannot become fixed by frost, however severe;
5th, Are the most accurate and unvarying measurers of Gas;
6th, Prevent jumping or unexpected extinction of the Lights;
7th, May be fixed either above or below the level of the Lights;
8th, Cannot be tampered with, without visibly damaging the outer case;
9th, Will last much longer than Wet Meters;
10th, Will not cost more than one-half for repair that Wet or Water Meters do;
Are upheld for five years without charge.

WILLIAM PARKINSON & CO.

(SUCCESSORS TO SAMUEL CROSLEY,)

COTTAGE LANE, CITY ROAD, LONDON, E.C.

Established 1816.

MANUFACTURERS OF PATENT

WET & DRY GAS-METERS,

STATION-METERS WITH PLANED JOINTS,

GOVERNORS, PRESSURE REGISTERS, GAUGES,

AND EXPERIMENTAL APPARATUS,

STREET-LAMP METERS,

AND REGULATORS FOR AVERAGE METER INDICATION.

METERS FOR MEASURING WATER.

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TO SUBSCRIBERS.

The JOURNAL OF GAS LIGHTING is supplied direct from the Office to residents in any part of the United Kingdom, at the rate of 21s. per annum, payable in advance. If credit be taken, the charge is 25s.

Subscribers who desire to avail themselves of the reduction in the subscription to the JOURNAL by paying in advance for the year 1878, are reminded that this can only be done during January.

Post Orders to be made payable at the Chief District Office, St. Martin's-le-Grand, London, to William B. King, 11 Bolt Court, Fleet Street, E.C.

Vol. XXX. (second half of 1877) will shortly be ready, bound in cloth, gilt letters, price 18s. Cloth cases for binding may be obtained on order from any bookseller, or from the Publisher.

TO CORRESPONDENTS.

CARBON *writes: "I can bear testimony to my brother manager's remarks in your last about Retort Carbon. For years I have sold mine at the same price as Newcastle coke. Our foundry people seek it up as soon as they know that we have any. They tell me it makes the metal run freer and quicker. I gave them the first lot for a trial; since then they always buy it."*

THE JOURNAL OF GAS LIGHTING,
WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, JANUARY 1, 1878.

Circular to Gas Companies.

THE threatened prosecution of the Chartered Gas Company by the Metropolitan Board of Works, for a deficiency of illuminating power on a certain date, and an actual prosecution at Cardiff for a similar default, compel us to make some remarks on tests and testing for illuminating power. The cases vary a little, for while, in the instance of the Chartered Company, the deficiency complained of was about one and two-thirds of a candle, at Cardiff the default was only one-third of a candle. The case against the Cardiff Company broke down on a question of jurisdiction; but we shall refer to it further on. Passing on to the intended prosecution of the Chartered Company, we should be disposed to call in question the propriety of taking proceedings for a deficiency of even a candle and a half; but the Company may admit the default. We notice that in this case an appeal was made to the Chief Gas Examiner. Upon what principles this functionary arrives at a decision, on appeal respecting a deficiency of illuminating power, we do not know. In the case of impurities, the *corpora delicta*, in the shape of the solutions obtained, are bottled up, and remain for examination in case of dispute. But the light of other days cannot be bottled up, and the standard of comparison has gone with the consumed part of the candles, and thus the Chief Examiner is left hopelessly in the dark as to the cause of the defect—that is, so far as the testing-station can reveal it. On a visit to the works, he might, perhaps, learn that, by inadvertence a truckload of cannel was deficient, or that, by some mishap or other, atmospheric air had found its way into the mains—neither of them very good reasons for mitigating the substantial penalty fixed for deficiency of illuminating power under the Metropolitan Acts. This, however, must be said, the Acts provide that the penalty shall be calculated upon all the gas made in the twenty-four hours, when it may be that the deficiency lasted only one or two hours. If the Company are to pay for the gas made during the whole of the day, it should be tested all through the twenty-four hours; but this is never done. Even now that no actual hours are prescribed for the testing, the examination of gas in the Metropolis cannot be said to be in a satisfactory state. We shall not go the length of saying, as some do, that the testing is a farce played at the joint expense of the Gas Companies and the rate-paying public; but we do say that, if the Gas Companies are to be prosecuted for small deficiencies of illuminating power, some alterations must be made in the arrangements which now obtain.

Returning to Cardiff, and the prosecution for a third of a candle, we may note the fact that four gentlemen of equal competence, operating at one time with that celebrated photometer at Fulham, arrived at greater divergencies in their determinations of the illuminating power of the same gas. It is an undoubted fact, that an allowance of, at least, one candle must be made for the several disturbing influences. Our readers know that we have always advocated the use of candles as the standard of comparison, and we retract nothing we have written on the subject. Still, we are willing to admit that candles have their defects. We have, in the vast majority of cases, found them to burn with great regularity; but, with a badly-made wick, the light given by the candle may, and, indeed, does, vary at every inch of its length. Thus a prosecution for a deficiency of one-third of a candle is worse than an absurdity. Even the most skilled Examiners—those whose whole time is occupied with the examination of gas—may be unconsciously misled; how much more so may this be the case with a country doctor, who has made but few tests in the course of his life, and has had no special training as a Gas Examiner. It is a misfortune for the Cardiff Gas Company that their Act prescribes the use of the old Argand burner. If Sugg's New "London" had been employed, we have no doubt that the gas would have afforded an illuminating power considerably above the standard. It may be worth their while to know that Mr. Sugg has a fifteen-hole burner, which will satisfy the requirements of their Act, while giving them all the advantages of the New "London." Probably the proceedings will not be resumed; but the Company should lose no time in providing the most modern appliances for gas-testing.

We insert to-day—we cannot say exactly with pleasure—what may be called the final appeal of Mr. R. H. Patterson. The statements he makes call for little remark, for the whole matter, we consider, has been sufficiently dealt with. We must make one exception, however, for his patent of 1873, though published in our columns, has never been remarked upon. We are glad to learn that the ammonia process described in this patent is in successful operation at the works of the South Metropolitan Company, and we should be pleased to hear of its adoption in many other works. On the general principles enunciated in his letter, we entirely agree with Mr. Patterson. Patentees undoubtedly suffer from the ignorance of the Judges who are required to adjudicate on their claims. We have had, in the course of our experience, to listen to judgments which clearly showed that the Judge had not the smallest conception of the nature of the case. This has been especially illustrated in the suits which involve the discussion of chemical points. In such cases we have always advocated the employment of expert assessors. The prejudices and conceit of the legal profession, however, stand in the way of such appointments, and thus it happens that gentlemen of great attainments, but with no special qualifications, are called upon to decide questions with regard to which they have no exact knowledge. Mr. Patterson, as an energetic writer for the daily press, may do some good for himself and his co-patentees if he will thoroughly ventilate this matter. We regret that the crowded state of our columns prevented us publishing his three days address in the House of Lords, but after the publication of the letter we print to-day we do not think he will suffer from the omission. The main points of the case, as presented to the Courts, were so fully noticed last week, that no further remarks are called for. Mr. Patterson has now his 1873 patent to work with, and we wish him all success.

The Corporation of Worcester are, as we have already informed our readers, hankering after the property of the Gas Company. They have been collecting statements of the price and quality of the gas supplied to one hundred and four towns, and they find that in some, gas is cheaper than in Worcester, and in many dearer, while differences exist in the illuminating power. But what they have not learnt is the varying circumstances and conditions which obtain in the several localities, and on which the price of gas must depend. Let the Corporation of Worcester get the works if they can, but let them well understand that they will

never be able to supply gas at a cheaper rate than that at which it might be furnished by the Company. The discussion in the Town Council has been postponed for a time, and we shall have to refer to the desired purchase again.

All we said recently about the Hastings Gas Company, and the price of gas in that town, is more than justified by the information which we have since received. The coal the Company use is landed at Whitstable, it is thence railed to Hastings Station, and from thence has to be carted to the works and trimmed. The *octroi* at Hastings is very high, and when the obligations of the Company to the town are considered, this tax should not be forgotten. As regards the question of the supply of gas to public lamps, we consistently advocate the adoption of the average meter system, which we hope will be followed at Hastings. Considering all things, we have every reason to believe that the price of gas in Hastings is perfectly fair, and we are surprised that intelligent people should object to so reasonable a charge.

The Radcliffe and Pilkington Local Board are raising a most unreasonable opposition to the Bill promoted by the Radcliffe and Pilkington Gas Company. They complain of the high price, bad quality, and insufficient supply, and now they seek to prevent the Company from obtaining powers which would enable them to remedy all the defects, and most probably to reduce the price. The Local Board have applied to the Central Authority for power to spend money in opposing the Bill, and have been, as a matter of course, referred to the provisions of the Municipal Corporations (Borough Funds) Act. They have accordingly resolved on calling a public meeting, to obtain sanction for the expenditure of money in opposing the Bill. Our voice may not be heard in Radcliffe, but, if it be, we strongly advise the ratepayers to keep their money in their pockets, and leave the Company, whose only object is, while, of course, earning some profit for themselves, to do the best for the consumers, and furnish an adequate and pure supply of gas.

To-day the Blackburn gas undertaking passes into the hands of the Corporation, and, much as we regret the transfer, we have no hesitation in saying that the terms obtained by the Shareholders have been fair and good, if not liberal. It is admitted that, as regards any profit to the Corporation, this must depend on the possible growth of the town, and the probable increase of consumption of gas. The growth of towns occupied by the cotton manufacture becomes more and more problematical every day. Bombay is becoming the centre of a cotton industry, which yearly increases in importance, and may eventually even compete with Manchester itself. Thus the prospects of the Corporation of Blackburn may not be so brilliant as their gas. Still, they have only acted in accordance with modern ideas, and the ratepayers must put up with the consequences. The Corporation have a hundred years to pay off the debt they have just incurred; but if the gas annuitants take our advice they will "commute, compound, and cut," with all possible speed.

An attempt has been made to apply the Burghs (Scotland) Gas Supply Act to North Berwick, but the inhabitants and the Commissioners were not in agreement; and at the town's meeting, held in accordance with the provisions of the Act, a poll was demanded, the result of which was favourable to its adoption. From some cause, however, said to be a legal blunder, the Provost has issued a notice to the effect that "the Magistrates and Town Council have resolved to abandon "the measure." We may take it that the Council were fairly beaten by the partisans of the Gas Company, and now the question of purchase must necessarily remain in abeyance for three years. In the meantime, the Council may acquire wisdom, and be content to allow a commercial undertaking to pursue its course unimpeded by useless agitation.

By an extract from the *Melbourne Argus*, which will be found in another column, it will be seen that something like the most modern Metropolitan Gas Legislation has been adopted in one of our most distant Colonies. We mentioned a few weeks ago that the three Companies supplying Melbourne had resolved on amalgamation, subject to the approval of the Victorian Legislature. That sanction has now been obtained; but at some little sacrifice on the part of the Companies. The amalgamated Company are saddled with auction clauses and sliding scale, and they are limited to the initial price of 7s. 6d. per thousand for fourteen-candle gas, a sum exceptionally low for the Southern Colonies. The Company have also failed to obtain the extended limits they wished for; but enough remains to make the united undertaking a most substantial concern. The Company asked for a standard dividend of twelve and a half per cent., which is only reasonable for the Colony; but the Legislature granted only ten per cent, stipulating that any excess of profit over ten per cent. should be equally divided between the Company and the Municipality. To obtain the twelve and a half per cent. the Company asked for, they will have to reduce the price of gas to five shillings. The day will soon come when a considerable extension of gas enterprise must take place in the Australian Colonies. New South Wales has sent to England some of the richest gas coal ever placed in a retort, and has in her dominions enough of different varieties to supply the whole Southern Hemisphere. Thus we may anticipate a good future for the amalgamated Melbourne Gas Companies. The Mother Country has occasionally borrowed hints from Colonial experiences, and this, of general amalgamation for the whole supply, may furnish one which may be usefully followed here. Melbourne, however, has a grievance. The Act passed by the Victorian Legislature does not compel a publication of the accounts of the Company; but this does not matter. Gas Companies have been accused of all sorts of rascalities; but every one who has been concerned in their management knows that in nine cases out of ten the accusations have been groundless.

We publish to-day an interesting account of the electrical apparatus devised by Mr. St. George Lane Fox for the simultaneous lighting and extinguishing of public lamps. Under ordinary circumstances, we have no doubt whatever of its efficiency, but we have a doubt as to what would happen if a heavy thunderstorm prevailed at the hour of lighting or extinguishing. This question set at rest, we could safely recommend the adoption of the apparatus to all Gas Companies and Local Authorities, and see with equanimity the disconsolate lamplighter and his family enter the workhouse in consequence of the march of science. We have, however, a strong suspicion that Mr. St. G. Lane Fox's invention will, like the electric candle, remain *in posse*, and the lamplighter will continue to enjoy a cheerful existence, except in bad weather.

We commend to the notice of our friends the letter of Mr. Bray, published in another column, which seems to open up a discussion that would be readily entered upon. The dimensions of a burner that may be successfully employed for the consumption of a given quantity of rich gas is one that can only be settled by the experience of the most expert manufacturers. We offer no opinion on the matter. The Referees burner is undoubtedly a good one; but probably a better may be devised, and Mr. Bray's opinion on the subject is worthy of all respect.

Water gas, which we cannot help thinking to have a promising future, especially as an auxiliary to coal gas, is, as will be seen by reports in another column, condemned in America. To speak frankly, we do not understand the reports of the chemists which we print. There must be errors somewhere, or we have been altogether misled as to the nature of the Lowe process. The proportions of the ingredient vapours and gases differ considerably from what we should expect; and the illuminating power, as detailed, is not what we should have anticipated under the several circumstances. We are not at all sorry that the experiment has failed; but, looking forward, as we do, to a day in which the manufacture of gas must be cheapened, we still entertain hopes that petroleum oils and the products of the decomposition of water may prove useful auxiliaries to Gas Companies.

Water and Sanitary Notes.

It seems that the two great reforms necessary to make London a complete Municipality will be brought before the attention of Parliament in the ensuing session. A Bill, the origin of which cannot be doubtful, we understand has been printed, which is to confer the benefits of an unitarian Corporation for the whole of the metropolitan area. Besides this, the Earl of Camperdown is to introduce a measure, which, for the moment, we regard as even of greater preliminary importance—to provide for the popular election of the members of the Metropolitan Board of Works, on the principle of the School Board elections.

The short, and probably stormy, sitting of Parliament which will open on the 17th, will be entirely occupied with foreign affairs, with which we have, here, nothing to do. Of what will be promised, as regards domestic legislation, in the Royal Address, we have, of course, no knowledge; but we may safely predict that metropolitan concerns will be left entirely neglected by the present Government. When, after that short and stormy sitting, Parliament re-assembles, about the middle of March, sloppy talk about British interests in the East will probably form the staple of the utterances of Government officials. Of real and earnest domestic legislation we do not expect to hear one word. There are, indeed, one or two questions which concern the territorial aristocracy more than any one else, which may occupy the attention of Parliament for some time; but these are simply questions of the transfer of land burdens to the Consolidated Fund. The prospect is not pleasing; but, so

far as our limited vision permits us to see, this is all, as regards domestic legislation, that we can expect to witness.

Nothing nobler could engage the attention of an energetic and really statesmanlike Government than the elaboration of a scheme for the municipal organization of the whole Metropolis, which should at once and for ever abolish Guzzledom and Vestrydom. Failing this, we would accept with pleasure Lord Camperdown's proposal for the popular election of the members of the Metropolitan Board. But it will not be accepted. In the meantime we notice that the most influential portion of the Metropolitan Press are now advocating the opinions which we have expressed for several years. Metropolitan improvements progress too slowly. Wide stretches of desert lie along every line of new street made by the Metropolitan Board, and for reasons which every business man will fully comprehend. In Paris, the vacant spaces caused by Haussmann's immense demolitions were rapidly filled up, owing, we believe, to the immediate sale of the freeholds. In this Metropolis, unfortunately, a very different system is pursued, and thus we have not a few spots vacant, in which nothing is produced for rates in the parishes in which they lie, and for nothing else.

We have received from the Thirlmere Defence Association an appeal to support their views. We are sorry that we cannot help them. Our opinions on the matter in question have been very plainly stated. With as keen a love for natural beauty as can be possessed by a human being, we still hold that the comfort and well-being of a large population are of infinitely more importance than the little alteration of the shores of a lake, offensive to the taste of a few Cockney tourists and artists. We go further, and, with some knowledge of the district, state a confident opinion that the aspect of the lake and its surroundings will not be altered for the worse if the designs of the Manchester Corporation are carried out. The enthusiasts who are now opposing the Corporation with all their might will, in the course of ten years, become perfectly reconciled, and probably discover new beauties in the object of their worship transformed into a useful reservoir. They will reflect, perhaps, that the heaven-sent rain, which now runs uselessly to the sea, blesses the inhabitants of a crowded city and its hardly less crowded suburbs, and even if (which we do not believe will occur) something which the sentimentalists may consider a disfigurement should take place, the eye would soon become reconciled to it. A new race of tourists springs up every year, and Thirlmere and its surroundings, whatever may happen, will ever continue to be an object of interest. While fully sympathizing with the Thirlmere Defence Association and their views, we still hold that the wants of Manchester are of paramount importance, and for that reason we give our fullest support to the scheme of the Manchester Corporation.

It is not at all improbable that another of the Lakes may be appropriated to a useful purpose. The Welsh scheme of the Liverpool Corporation is certain to be opposed by every one interested in the Severn. They may get either Haweswater, Ullswater, or Windermere without any difficulty, and to one of these sources, we believe, they will eventually be driven for the additional supply they need.

Some very useful work has been done by Mr. G. W. Wigner, F.C.S., who has analyzed the water supply of most of our southern seaside health resorts. For the most part, the waters cannot be considered unsatisfactory, while some are reported excellent in quality. A few, however, have been strongly condemned. We hope when Mr. Wigner has completed his examinations, the scattered papers in the *Sanitary Record* will be collected in a volume, and made more generally accessible. Little as we believe in the transmission of disease by means of a water supply, it is always satisfactory to know when the supply is pure. A knowledge that the water was good at a certain place would decide many visitors in the choice of a holiday resort, and we might predict a large circulation for Mr. Wigner's book, if he should see fit to publish one.

The Vestry of Paddington, having an exceptional opportunity, have resolved on doing their own dusting, slopping, and watering, and so saving £3900 a year. The resolution, we think, is wise. The contract system, which, on commercial principles, we would advocate, works badly. It is, unfortunately, to the contractor's interest to neglect his work, and since competition in the business—the few Golden Dustmen having it all their own way—is out of the question, the contract prices are reported as exorbitant. Golden Dustmen, however, are rapidly disappearing. One by one the Metropolitan parishes are taking the work into their own hands, and, in the main, do it well. Energetic and intelligent superintendents are the only things necessary for complete success, and if Paddington secure these, the ratepayers may be congratulated on the change.

DESTRUCTIVE DISTILLATION.*

Under a somewhat affected title, Dr. E. J. Mills has published a little manual which, in a small space, conveys a great deal of useful information. The exceptional opportunities enjoyed by the author, as the holder of a professorship endowed by Mr. Young, the eminent paraffin oil distiller, has enabled him to acquire a large amount of practical information, and we only regret that, instead of producing this "Manualette," he has not written a larger work, giving full details of the industries here so briefly described. Dr. Mills is a philosopher, and begins at the beginning. He tells us at starting that destructive distillation is carried on in a retort, followed by a condenser and receiver, and that the substances to be operated upon are placed in the retort, information useful if not particularly novel. The work treats, in successive chapters of the production from coals and shales of paraffin oils, the mode of purifying which is pretty fully described. Then of the distillation of coal and wood tars, with an account of the products. Then follows a description of the mode of distilling rosin, and the products obtained, and, subsequently, chapters on the distillation of lignite, bone oil, and the rectification of petroleum. All these contain useful information, which we regret has not been more extended. We make the following extracts from the chapter on the distillation of coal, mainly for the purpose of putting our readers in possession of the most recent chemical nomenclature and formulæ, and in some instances the corrected boiling points of the various substances obtained.

Coal tar is formed by the destructive distillation of coal at a high temperature, usually a bright red heat, or beyond. Although it contains fatty hydrides, they are chiefly liquid ones, and not paraffin. Among its constituents are aromatic hydrides (of which traces only are found in natural or artificial petroleums), their alcohols (occurring in very small quantities in petroleums), and naphthaline (absent from petroleums). Chrysene occurs both in the low and high temperature oils.

If the general formulæ of fatty be compared with those of aromatic compounds, as in the following examples—

—	Fatty.	Aromatic.
Hydrides	CnH_{2n+2}	CnH_{2n-6}
Alcohols	$CnH_{2n+2}O$	$CnH_{2n-6}O$
Olefines	CnH_{2n}	CnH_{2n-8}

we observe that aromatic bodies contain eight weights of hydrogen less than the corresponding fatty bodies. Thus is the high temperature industry, to the extent that it is specially characterized by aromatic compounds, *a dehydrogenizing process.*

Purified coal gas contains about 0·5 volume of hydrogen, rather more than 0·3 volume of marsh gas, 0·05 volume of olefines, and 0·05 volume of carbonic oxide.

The treatment which the crude tar undergoes is remarkably similar to that to which crude paraffin oil is submitted. The liquor is separated from it, and treated for ammonia exactly as in the low temperature industry, and yields about the same per centage return.

Coal yields from 1 to 2 per cent. of liquor, from 3 to 6 per cent. of tar, and about 50 to 70 per cent. of coke (containing 2½ per cent. of ash); the remainder represents the yield of gas and the working loss (about 10 per cent.). It is usual to distil coal, or such a mixture of coals, as shall yield about 9000 cubic feet of gas (sp. gr. 0·6) per ton, or about 20 per cent.

Modern tar is, as a rule, heavier than the liquor; this must necessarily be the case where naphthaline is produced in quantity. It is treated with steam (or distilled with one-fifth of its volume of water, or distilled by the heat of a steam coil) to remove light naphtha, or crude "benzol." The stills hold from 500 to 4000 gallons, and are horizontal cylinders. The steam brings over about 10 per cent. at most of light naphtha (sp. gr. 0·78 to 0·83†), and some ammoniacal water, which is treated like the other "liquor." The residue of the distillation is heated by fire to about 200°, when most of the heavy oil comes over, and afterwards to over 300°. The residual pitch, which amounts to 30 to 50 per cent. of the tar, is, after several hours cooling (either in the still or a separate tank), run off into moulds; it is generally utilized for "asphalte," by mixture with about four times its weight of sand, chalk, or other inert material.

The light naphtha is run off the "liquor" beneath it, and churned with about 5 per cent. of oil of vitriol, and afterwards with about 2 per cent. of caustic soda (in aqueous solution, of sp. gr. 1·4). Lime may be advantageously used instead of soda, if great care be taken to avoid excess. Sometimes the naphtha is distilled between the acid and alkaline treatment; on the other hand, the lime and acid treatment may be performed, if desired, in the same tank. Mixtures of lime and caustic soda are also used; and this is probably the preferable course. It is also undoubtedly advisable to re-distil the crude benzol before submitting it to this chemical treatment. The residues of this second distillation, when mixed with lime, yield a lubricating "grease," as is the case with several genera of unsaturated hydrocarbides. Finally, the purified benzol is distilled by steam. It then has a specific gravity of about 0·86.

The heavy or "dead" oil may be used, as such, for preserving or "kreasoting" timber. It is more commonly distilled. The earlier portions of the distillate (150° to 200°) contain phenol and its homologues ("kreasote"); the following portions (200° to 212°) are rich in naphthaline; and the next fraction (to 360°) yields crystals of anthracene on cooling. Naphthaline is not at present utilized on the large scale; but anthracene is the source of artificial alizarine. Tar yields rather less than 1 per cent. of anthracene. The mother liquid of the anthracene, after further concentration by distillation, and a second deposition of crystals, is chiefly valuable for illuminating and, more especially, for lubricating purposes. The treatment of the phenol fraction is the object of a special industry, that of carbolic acid. There can be little doubt that the future economical treatment of dead oil, and, in general, crude oils of high boiling point, will, in the main, turn upon some method of distillation *in vacuo*.

Annexed is a table of the known products of the destructive distillation of coal. The formulæ, boiling points, and melting points are added, so far as known.

* "Destructive Distillation: A Manualette of the Paraffin, Coal Tar, Rosin Oil, Petroleum, and Kindred Industries." By E. J. Mills, D.Sc. (Lond.), F.R.S., "Young" Professor of Technical Chemistry in Anderson's College, Glasgow. London: Van Voorst, 1877.

† Formerly this distillate was allowed to reach the sp. gr. 0·95.

Destructive Distillation of Coal.

Name.	Formula.	Boiling Points.	Melting Points.
Hydrogen	H_2	—	—
Methylic hydride	CH_4	—	—
Hexylic	C_6H_{14}	68°	—
Octylic	C_8H_{18}	119	—
Decylic	$C_{10}H_{22}$	—	—
Paraffin	C_nH_{n+2}	—	—
Ethylene	C_2H_4	—	—
Tritylene	C_3H_6	—	—
Pentylene	C_5H_{10}	31	—
Hexylene	C_6H_{12}	71	—
Heptylene	C_7H_{14}	97	—
Acetylene	C_2H_2	—	—
Crotonylene	C_4H_6	18	—
Hexoylene	C_6H_{10}	80	—
Benzol	C_6H_6	80	3°
Parabenzol	C_6H_6	97	—
Toluol	C_7H_8	111	—
Xylols (3)	C_8H_{10}	139	—
Cumol (?)	C_9H_{12}	166	—
Mesitylene	C_9H_{12}	163	—
Cymol	$C_{10}H_{14}$	177	—
Naphthaline	$C_{10}H_8$	218	79
Anthracene	$C_{14}H_{10}$	360	213
Methanthracene	$C_{15}H_{12}$	—	196
Chrysene	$C_{18}H_{12}$	—	249
Retene	$C_{18}H_{18}$	—	—
Pyrene	$C_{16}H_{10}$	—	142
Water	H_2O	100	0
Hydric sulphide	H_2S	—	−85
Hydric sulphocyanide	HCNS	—	—
Carbonic oxide	CO	—	—
Carbonic dioxide	CO_2	−78	—
Carbonic disulphide	CS_2	47	—
Sulphuric dioxide	SO_2	−10	—
Hydric acetate	$C_2H_4O_2$	120	15
Phenol	C_6H_6O	188	35
Cresol	C_7H_8O	230	—
Phlorol	$C_9H_{12}O$	219	—
Rosolic acid	$C_{20}H_{16}O_4$	—	—
Brunolic acid	$CxHyOz$	—	—
Ammonia	NH_3	−33	—
Butylamine	$C_4H_{11}N$	75·5	—
Aniline	C_6H_7N	182	—
Cespitine	$C_8H_{13}N$	96	—
Pyridine	C_5H_5N	115	—
Picoline	C_6H_7N	134	—
Lutidine	C_7H_9N	154	—
Collidine	$C_8H_{11}N$	170	—
Parvoline	$C_9H_{13}N$	188	—
Coridine	$C_{10}H_{15}N$	211	—
Rubidine	$C_{11}H_{17}N$	230	—
Viridine	$C_{12}H_{19}N$	251	—
Leucoline	C_9H_7N	235	—
Lepidine	$C_{10}H_9N$	260	—
Cryptidine	$C_{11}H_{11}N$	—	—
Pyrrhol	C_4H_5N	133	—
Hydric cyanide	HCN	26	—
Fluorene	$C_{13}H_{10}$	302	—
Phenyl	$C_{12}H_{10}$	239	70
Acenaphthene	$C_{12}H_{10}$	269	100
Phenanthracene	$C_{14}H_{10}$	340	99
Carbon (hydrogenated)	Cn	—	—

The total amount of coal mined in 1874 was about 260 million tons. Of this, the United Kingdom produced about 125 million tons, 8 per cent. of which may be taken as used for gas-making; this would correspond to about 450,000 tons of oily tar.

We may conclude by strongly recommending this "Manualette" to all our readers who may desire to obtain information on the subjects of which it treats.

A TREATISE ON THE SCIENCE AND PRACTICE OF THE MANUFACTURE AND DISTRIBUTION OF COAL GAS.

CLIII.

District Governors.

The pressure of gas in the mains varies according to the elevation, increasing at the rate of nearly one-tenth of an inch for each 10 feet of rise, or about an inch for every 100 feet, and decreasing in the same proportion for a similar amount of fall.

The explanation of the phenomenon is found in the laws which affect the relative pressure of aëriform fluids of varying densities at different altitudes. As the elevation increases, the atmospheric pressure diminishes, and *vice versâ*. So that if the pressure as given by the weight of the gasholder, or of the governor, as the case may be, is equivalent to a column of water of 2 inches at the works, at a height of, say, 100 feet the gas is relieved of that amount of atmospheric pressure, which, after allowing for the gravity of the gas, is equal to a column of water nearly 1 inch in height; hence the pressure at this point will be about 3 inches.

The amount of increase and decrease, of course, depends on the specific gravity of the gas. The greater that is, the less the variation, and *vice versâ*; and, supposing a holder inflated with atmospheric air instead of gas, no variation of pressure would be found to exist at different levels.

Philosophically stated, the reverse of the received axiom is the truth, because the higher the elevation of the main, the less the actual pressure of the gas; just as the higher we ascend into the atmosphere the less we find the atmospheric pressure to be. The difference in pressure, as indicated by the gauge, is due to the different ratios of the specific gravity of the gas and the air, thus:—

	Inches.
A column of air 100 feet high is equal in weight to a column of water of a height of	1·473
A column of gas 100 feet high, specific gravity ·320 (air being 1·000), is equal in weight to a column of water of a height of	·473
Difference, pressure indicated by the gauge	1·000

Gas-works are usually erected at or about the lowest part of the district of supply, with the object of taking advantage of this natural law of the increase of pressure as the main rises, so that the diminished pressure caused by the draught on the main during the hours of consumption may be compensated for by the natural increase. As many districts are extremely irregular in their surface level, the highest parts in some instances being considerably above the lowest, it follows that the like irregularity characterizes the pressure in the main, which, if the lower portions of the district are adequately supplied, must be excessive in those more elevated.

We will suppose that the initial day pressure given at the gas-works, and in the lowest parts, is 7-10ths of an inch; if the levels of the district vary to the extent of 100 or 200 feet, the pressure at the former will be 17-10ths, and at the latter 27-10ths. Again, during the lighting hours, when the initial pressure is increased to, say, 15-10ths, the pressure at those elevations, provided the mains are adequate in size, and allowing for the draught upon them, will range from about 22 to 32-10ths respectively. These high pressures are excessive and wasteful, causing heavy leakage wherever faults exist in the mains and services, such leakage being in the proportion of the square root of the pressure.

To reduce these excessive pressures in the more elevated parts, district governors are necessary, and their adoption invariably results in a saving that, in a brief space of time, more than compensates for the expenditure incurred by their application.

The ordinary governor would answer the purpose of reducing the pressure, and it has been so applied, being adjusted so as to give the maximum night pressure on its outlet. This is a very partial remedy for the evil. To obtain the full advantage from them, they would have to be adjusted every morning to the pressure needed in the daytime, but in order to give the additional amount required during the hours of consumption, a re-adjustment would require to be made every evening at dusk, which would entail the attendance of a person at each governor, for that purpose. This is a fatal objection to their employment, even if their dimensions were suitable. A special kind of apparatus has, therefore, been devised, which, whilst occupying but little space, effects automatically, or by means of the pressure given at the works, the desired changes during the 24 hours.

Separate and distinct mains are laid from some works to the districts at the different altitudes, and as the pressure on each of them is controlled by its own governor, the difficulty is in this way partially overcome. This is a good arrangement wherever it can be carried out at a reasonable expense, but it is not always practicable to do so; and even when it can be done, it may with advantage be supplemented by the use of the district governor.

The first, or one of the first applications of a district governor fulfilling the conditions indicated, was made by the late Mr. Joseph Adamson, when engineer of the Leeds New Gas Company. The governor invented by him, and which is represented in section and elevation in figs. 1 and 2, somewhat resembles the throttle-valve of a steam-engine, contained within a straight pipe connected to the line of mains. The valve, A, is formed of two discs of tin, with a disc of oiled leather, similar to that employed in dry gas-meters, rivetted between them, and so arranged as to allow of the full orifice

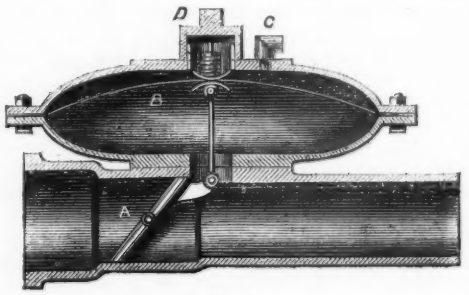


Fig. 1.

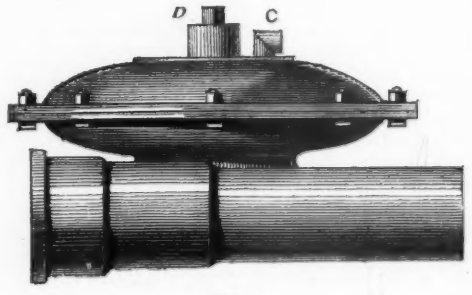


Fig. 2.

of the pipe being opened if required. The actuating diaphragm, B, is also of leather, secured between the flanges of the cast-iron chamber over the main. The space in the chamber above the diaphragm is open to the atmosphere by means of an air-pipe connected to the elbow, C, carried to a height of 10 or 12 feet up the side of any adjacent building. A removable cap, D, admits of the adjustment of the valve, by means of small weights to give any desired pressure.

The governor, which is simple in construction and effective in its action, works with but little friction, and any liquid produced by condensation in the main passes through to the ordinary syphon-well, so that there is no danger of obstruction from this cause.

The late Mr. Orlando Brothers invented a district governor, which is represented in the annexed engraving, fig. 3. It consists of an outer

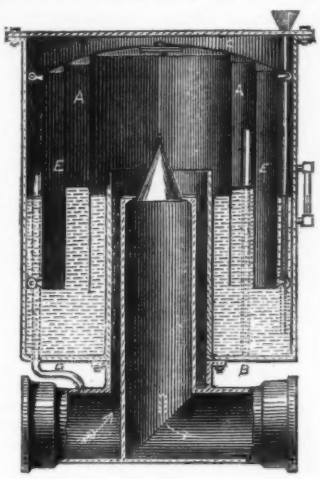


Fig. 3.

cylindrical case, with inlet and outlet pipes arranged as in the ordinary station-governor. The holder or bell is formed with a difference chamber, marked A on the drawing, and this is open to the atmosphere by means of the pipe, B. The outer case is closed at its upper end by a plate or cover, and between this and the top of the holder, C, the inlet gas is admitted by the pipe, D. The inlet-gas pressure acts also on the under side of the holder crown; but as the area of the space on which the pressure exerts its force underneath is circumscribed by the space occupied by the difference chamber and the air-chamber or float, the downward pressure acting upon the whole surface of the crown gently overcomes the upward pressure, forcing the float downwards, and so opening the valve. E is the air-chamber or float, and as this extends from top to bottom of the holder, the deeper the latter is immersed in the water the greater the buoyant power exerted to close the valve. The several chambers described are proportioned in area to each other according to the size of the apparatus.

In adjusting the governor, water is run in until the pressure is reduced on the outlet side to what is required in the daytime, and, by thus regulating the water-line, any desired outlet pressure, being less than that of the inlet, can be given, dependent, of course, on the changes made in the pressure at the gas-works.

(To be continued.)

Correspondence.

[*We do not hold ourselves responsible for the opinions expressed by Correspondents.*]

PATTERSON *VERSUS* THE GASLIGHT AND COKE COMPANY.

A FINAL APPEAL.

Sir,—With reference to your remarks on the failure of my appeal to the House of Lords, permit me to make the following observations. To the tone and spirit of your remarks I have nothing to object—I gratefully acknowledge their fairness and good feeling; but in some of your statements you have inadvertently erred, and there are one or two others which I desire to refer to on my account, and indeed also of patentees generally.

(1.) You are mistaken in saying that my experiments in connection with the half-dozen various processes, included in my patent, were made at the expense of the Gas Companies or the public. The whole of the expenses for apparatus, materials, and assistance were paid for by myself; and the receipts for these disbursements are still in my possession.

(2.) On the very first clear day (the 11th of March) after my patent was filed, I called upon and showed my patent to the three Gas Companies with whom the Referees had to do, stating that they might have the use of each and all of my processes "at a merely nominal royalty." No objection of any kind was made to my patent—indeed, the only question was: "Will it do?" And the Secretary of the Chartered Company said to me: "I do not see why you should be so generous; if your process is worth using, it is worth paying for." Contrast this with the conduct of patentees generally.

(3.) None of the experimental processes tried in gas-works, whether at the suggestion or even within the knowledge of the Gas Referees, had any bearing upon or connection with my inventions. These experiments (as stated in evidence and unquestioned) were—firstly, two processes of Mr. Vernon Harcourt's, which the Referees were required to obtain a trial of, by the President of the Board of Trade, then Lord Carlingford. Secondly, there was Mr. Evans's superheated-steam process—experiments which, it is hardly necessary to say, were instituted by Mr. Evans himself, but which the Referees had opportunities of seeing at work. Lastly, there was Dr. Letheby's latest and pet proposal to admit ammonia into the lime purifiers; and this was the only experiment in gas-works suggested spontaneously by the Referees, and, of course, it was an entirely costless operation. Each and all of the processes thus tried proved entire failures, and, obviously, not one of them had any bearing upon any part of my patented inventions.

In fact, the only experience and information obtained by the Referees from the Gas Companies and their officers, upon this long-existing sulphur difficulty, was the experience and information of failure—as, indeed, was constantly stated by the Companies and their officers themselves down to the time when I showed my specification to the Companies on March 11, 1872, Mr. Harris, among others, stating that he had "no control" over the sulphur, nor any knowledge as to the cause of the extraordinary fluctuations, and that the Companies would not be safe under even a 50 or 60 grain maximum.

(4.) You make, perfectly naturally, a mistake in repeating the allegation so strangely made in Lord Justice James's judgment—that the Beckton report was delayed in its issue, in order that, in the meanwhile, I might patent my new processes, one of which, out of the half-dozen, being described, with my permission, in that report. That Lord Justice James should have made such a statement only shows how imperfectly he and his colleagues had read the evidence. As I showed to the House of Lords (with the signified acquiescence of the Lord Chancellor), such a statement was wholly unfounded, the defendants themselves expressly stating in their "Answer" that the report had been kept back "at the request of some of the Company's officers;" and the same fact is shown in half-a-dozen parts of the evidence which I read before the House of Lords. The Referees, as soon as they had the Beckton report in type before them, on the 31st of January, considered the report incomplete, and applied for certain reports from the Chartered Company, which were promised by the Secretary of the Company, who at the same time urgently requested by letter that the Referees should "withhold their report" on the Beckton works until the Company could make their further communications. In fact, my patent was filed on the 9th of March, and the Beckton report was not issued until the 26th. And the House of Lords, with this superabundant evidence before them, dropped this most baseless charge made by Lord Justice James—a charge, I repeat, which the defendants themselves repudiated, and, by their "Answer," contradicted.

(5.) Your objection to my second claim, or rather to the first part of it, for the second part is unnoticed either by you, or by the Lords Justices, or by the House of Lords, is (although I object to it) perfectly intelligible, and fairly arguable. Your objection is this—that although the said process is a valuable improvement (I should think it is), nevertheless, as old materials and apparatus are employed, the process is not sufficiently novel and distinctive to be the proper subject of a patent. And this was the judgment of the Lords Justices in the intermediate Court of Appeal. They also said that the first time that any mention of the said process is to be found in all the voluminous evidence is on Jan. 31, 1872, when our "Beckton Report" was for the first time in type or proof; but they held that subsequently thereto (neither time nor circumstance being mentioned by their lordships, or anywhere alleged in the evidence), I had communicated the said process to the Chartered Company, and that some "prior user," although admittedly unsuccessful, had taken place a few days before I filed my patent.

This was the judgment of the Lords Justices, upon which point they were directly at variance with Vice-Chancellor Bacon, before whom the whole case had been minutely investigated for no less than 17 days, and who, having seen and heard the witnesses in Court, acted as jury as well as judge. It is important to note that the House of Lords did not adopt the view taken by the Lords Justices. The House of Lords did not hold that my second claim, or any part of it, was not the proper subject of a patent. And this is a very important matter as regards other patentees. The House of Lords saw (from the evidence on both sides) that, besides the employment of the old materials, there were entirely new testings, and also new machinery or appliances for testing the old materials and apparatus—these testings, both for CO_2 and CS_2, when thus employed (and as they are employed both at Bow and Beckton, and now in London gas-works generally), being not only novel in themselves, but also requiring special apparatus, it being impossible to employ these tests in such a manner without having special apparatus for preparing the gas for the making of these tests—viz., by previously extracting the SH_2 with which the gas is fully charged at the points where these new testings are applied.

In fact, my second lime process is far more distinctive in its character, and more readily recognizable than the vulcanite patent or a hundred others, the validity of which patents has been approved by the Law Courts. Neither did any of the defendants witnesses allege that the said process was not readily recognizable. And, as you are well aware, both before the Committee of the House of Commons on the Sulphur Question last session, and in the recent Bromley nuisance case tried before Mr. Justice Fry, "Patterson's Process" was referred to again and again, both by chemists and gas engineers, as a process which needed only to be so called to be at once understood in the gas world.

(6.) The grand objection taken, and unanimously held, by the House of Lords, and which proved fatal to my patent, is one which was quite new in the case; that is to say, it is one which was not adopted by the Court of Appeal, and which (although pleaded by the defendents counsel when their original objections had failed or were in jeopardy) was not contained in any shape in either the "Answer" or the "Further Answer." Evidently, to my mind at least, the House of Lords had overlooked this fact; for, according to all legal principles and practice, it is not allowable to raise or to give effect to any objection which has not been clearly set forth in the "Answers" or original pleadings, and for which, of course, the plaintiff could not be prepared either with evidence or with argument. And I was not heard upon this point, the Lord Chancellor stopping me when I began to deal with the respondents "Printed Case," on the ground that it was "unusual and inconvenient

to do so at this stage of the procedure," and I was allowed no other opportunity.

This grand objection to my first and second claims, held unanimously by the House of Lords, and which, as a necessary consequence, has proved fatal (temporarily, at least) to my whole patent, as you correctly state, was this: They held that the Gas Referees are bound to assist the Gas Companies in improving the processes of gas manufacture; and that any Gas Referee who discovers an invention in gas manufacture, or who in any way (whether confidentially or not) becomes aware of any method of improvement, is bound to give information to the Gas Companies of that new process or improvement, as soon as he himself becomes aware of it. Accordingly, as admittedly I had communicated my lime process to my colleagues (although the communication was made by me, and accepted as confidential), this was to be regarded as equivalent to a "publication" of my process. This much was held unanimously by the House of Lords. But the Lord Chancellor went further. According to his lordship's judgment, the effect would have been the same, even had I not communicated my invention to my colleagues; his lordship holding that, even had I kept my invention to myself, nevertheless this purely private knowledge on my part must be held (of course, by a legal fiction) to be public knowledge, inasmuch as, according to his lordship, every Gas Referee is bound in duty to convey his knowledge at once to the Gas Companies, and therefore must be held to have done so. As it seems to me, the Lord Chancellor adopted this extreme view because he felt the weakness of the legal fiction of maintaining that a communication of an invention made confidentially, and which certainly was not communicated either to the Gas Companies or to the public, was a publication, or rather could be held to be, a publication or a piece of public knowledge.

This, I say, is the Lord Chancellor's judgment on the matter. Lord Blackburn, however, differs upon this point, holding that publication of the lime process would not have been made had I not communicated my discovery to my colleagues prior to filing my patent. Lord Blackburn says: "If the date of the report had been after the date of the patent, the case upon this would, it seems to me, have been quite unarguable. The date of the patent was, however, before the contents of the report were known to the Gas Companies, though several weeks after they were known to the whole of the Gas Referees and their Secretary; and, as I have already pointed out, the moment the Referees became aware of what was stated in the report, it became the property of the public. . . . The Referees were bound to make it known, and even if they kept it back, the invention was no less the property of the public from the time the Referees knew of it."

(7.) Then as to the evidence on other points. The Court of Chancery held my patent valid in every respect, both of fact and of law, the technical framing of the patent included. The Court of Appeal (besides holding that the last three claims were useless, although one of these processes is in successful operation at the South Metropolitan works) held that I was the discoverer of the lime process, but that I communicated it to the Chartered Company, and that some "prior user" of it had taken place before my patent was filed. Further, the Court of Appeal held that my second claim was not patentable. The House of Lords unanimously dropped the objection to the last three claims, and also to the patentableness of my second claim, and also dropped the "prior user" (as distinct from the question of non-novelty) of the lime process, and the Lord Chancellor and Lord Gordon also dropped the objection to the non-novelty of the lime process, except by the above-mentioned "publication" thereof by a fiction of law.

In my statement of my case (which I regret you do not report) I read to their lordships plain admissions of the novelty of my lime process, and direct statements against any "prior user" of it having taken place either at Bow or Beckton, made in Court by the Company's own witnesses. For example, Dr. Odling, who had "fully inspected" the Beckton works a few days before, and again a few days after the date of my patent, is asked, relative to the new lime process, Q. 920: "It had not then (March 28) been tried on a manufacturing scale?—No." "You did not know whether it would succeed?—No." Then, after he describes what used to be done at Bow, he is asked, Q. 995: "That was essentially different from what was recommended by your lecture (viz., the new lime process) in 1872?—Yes." "No process similar to that recommended in your lecture in June, 1872, was carried on at Bow, to your knowledge, up to the date of that lecture?—No." Finally, Dr. Odling states, Q. 1050: "I thought the report of the Referees and my own report were jointly new. It seemed to me then, in ignorance of Mr. Mann's patent, that we were the first to definitely point out the principles applicable to gas manufacture; but I find that, with regard to pointing out the principle, we have been forestalled by Mr. Mann. At that time I should have claimed rather more than a mode of doing it; I should have claimed, as Mr. Patterson does, the enunciation of the principle of doing it."

Can there be better testimony to the entire novelty of my lime process than this? And next to this direct testimony of Dr. Odling, this abortive and dropped patent of Mann's (wherein he stumbles at the first step, taking no note of the CO_2 as preventing the formation of CaS in lime purifiers) proves conclusively how entirely novel my invention was. It is true that Lord Blackburn expressed the opinion that the present process at Bow—viz., the present "measuring of the gas," together with testings for CO_2 and SH_2 on the first lime purifier, and for CS_2 on both the first and second lime purifiers, as well as upon the manufactured gas—had all been adopted in 1867!—although Mr. Harris stated that he "could not remember" when these testings were first employed; and although the foreman at Bow stated in Court that the present method had been adopted only "three, four, or five years ago"—three years ago being, at Christmas, 1872, more than ten months after the date of my patent. Indeed, the opinion of Lord Blackburn upon this matter (and also, I may say, the confounding of my first and second processes, which are distinct, and the former of which has not been in use even to this day) shows, I submit, how seriously patentees may suffer at the hands of the law, when judges are not adequately conversant with the manufacturing operations to which the patent relates. As the result of my five years experience in patent legislation, I advise every patentee to trust his case to a jury, rather than to the hair-splitting technicalities of pure "law."

I am much disappointed that you have been unable to give a report of my statement before the Lords, wherein I set forth the evidence of the defendants own witnesses in my favour, and which makes plain why it was that the House of Lords (at least as regards the majority of their judgments) dropped almost all, if not every one, of the objections sustained by the Court of Appeal—notably (1), the objection to my three last claims; (2) the alleged "prior user" of my second claim; and (3) the objection that my second claim was not a patentable invention—the judgment of the House being given against me upon a purely legal point—a point, too, which had not been held in the Court of Appeal, and which was not even set forth in the defendants "Answers!"

The effect of this decision will be of the widest importance to patentees. I know that not a few leading men in the gas world are not "glad" at this decision, believing, as they do, that this most valuable invention has been most unjustly dealt with; and the clever class of gas managers (the men who can make inventions) will have reason to regret it on their own account. Since a Gas Referee who, according to the terms of his appointment, and as hitherto believed, has nothing to do with conducting the business of gas companies, is held disqualified from holding a patent, this will *à fortiori* hold good with gas managers and *employés* in every branch of manufacture—these men being paid for the express purpose of conducting the business to the best of their ability.

In conclusion, and as a matter relating to myself, let me say a word as to your concluding sentence. You say: "The special misfortune to Mr. Patterson is that one part of a patent being held to be untenable, the whole is vitiated; and thus he loses his right to the methods of purification in closed vessels, of the success of which we had, and still entertain, great expectations. It may now be too late for a disclaimer."

Now, apart from the question of disclaiming, there is my second patent of January, 1873, when I was not a Gas Referee, and which includes, *inter alia*, the entire purification of coal gas by ammonia, obtained as an impurity from the gas itself. But take the case as you put it. What does it mean, but this? that the London Gas Companies, so great and wealthy, are now to sing in chorus, "Hurrah! We have now got not only Patterson's two first processes, one of which we have been using for the last four or five years, but we can now get his other and still better processes for doing the whole work of purification in closed vessels, and so without nuisance, and also cheaper than by lime and purifiers. We can now bag his whole patent; so let us rejoice over the plunder! Patterson did for us what we and all our officers and consulting chemists had tried in vain to achieve for 20 years. We are already free from fear of penalties, while our gas (*vide* Harcourt, Tidy, and others before the House of Commons Committee) is worth twopence extra per 1000 feet from its increased purity; and this by a process which of itself adds 10 or 12 per cent. to the illuminating power, making an equal saving in our coal accounts, and an almost entire saving of cannel. And now, in addition, we can get Patterson's other and still better and still cheaper processes into the bargain!" I need not make any comment upon this. It speaks for itself; and the whole story of Patterson's patent, and the solving of the Sulphur Question, will remain memorable (I shall not use a less agreeable word) in the history of gas manufacture and its inventions.

22, *Wingate Road, Hammersmith, Dec.* 22, 1877. B. H. PATTERSON.

NAPHTHALINE.

SIR,—A short analysis of M. Brémond's paper, descriptive of his process for the prevention of the deposit of naphthaline by the desiccation of the gas, and a comparison of the same with Mr. Aitken's process of desiccating gases, will show wherein the two differ.

M. Brémond, after referring to the great trouble entailed by the deposition of solid naphthaline in mains and branch-pipes, says that, up to the date of his researches on the subject, the only remedies proposed for counteracting the effects of naphthaline were all based either upon its solubility in tar—for example, by the prolongation of the contact of the gas with the tar—or upon its solubility in the oils of naphtha, petróleum, &c. He then asked the question, Are these remedies, when properly applied, sufficient to remove the naphthaline? And his answer is substantially to the effect that they are sufficient to remove the naphthaline produced in the retort during the process of destructive distillation; that, after the condensing and purifying apparatus have been passed, naphthaline does not remain in the gas—at least, in such quantities as to cause precipitation in the mains. But he says, further, although the naphthaline at this stage of the manufacture is removed, the precipitation of naphthaline in the mains, &c., is not prevented, for naphthaline is subsequently produced by synthetical reactions between some of the other hydrocarbons ordinarily contained in the gas, those reactions being due to the heat given out by the condensation of the aqueous vapours; or, at any rate, whatever may be their cause, those reactions do take place, because naphthaline is not deposited when the gas is entirely deprived of its water vapour.

The principal reason which M. Brémond assigns for the advancing of this new theory of the formation of naphthaline synthetically from some of the constituents of the gas, by the agency of the latent heat of the condensed water vapour, and for abandoning the idea of its pre-existence in the gas after its purification of the crystalline naphthaline which is deposited in the mains, &c., is, that if the crystallization is preceded by the condensation of the aqueous vapours contained in the gas, it obeys a law which might be thus expressed: In a mixture of several vapours, when one of these vapours attains its point of condensation, it displaces the point of condensation of the vapour with which it is mixed. He says that, up till now, this law has been neither laid down nor verified, that he has submitted it to the judgment of experienced physicists, and that he is authorized to say it is at the present moment the subject of study by the learned professor of physics, the superintendent of the College of France.

In your editorial of Oct. 16, you indicated your doubts as to the truth of this theory of the synthetical formation of naphthaline from the constituents of the gas, and, to my mind, the experiments you advised M. Brémond to make would have very clearly proved the justness of your conclusions, and convinced M. Brémond that his theory was without foundation. I shall, therefore, not further refer to this part of his theory, but confine myself to proving that the law relating

to the tension of mixed vapours, which he asserts has neither been laid down nor verified, is both well known and widely applied.

There is no standard work on physics which does not give Regnault's experiments on the tension of the vapours of mixed liquids. These experiments prove that—1, when two liquids exert no solvent action on each other, such as water and bisulphate of carbon, or water and benzole, the tension of the vapour which rises from them is nearly equal to the sum of the tensions of the two separate liquids at the same temperature—*i.e.*, that the vapours from such liquids act towards each other as permanent gases. 2. With water and ether, which partially dissolve each other, the tension of the mixture is much less than the sum of the tensions of the separate liquids, being scarcely equal to that of ether alone—*i.e.*, the limited solvent action of the vapours for each other prevents or counteracts their power upon each other as permanent gas. 3. When two liquids dissolve each other in all proportions, as ether and bisulphate of carbon, or water and alcohol, the tension of the vapours of the mixed liquids is intermediate between the tension of the separate liquids—*i.e.*, the vapours act towards each other as if they were the vapours of the same compound. The above is just the inverse of the law given by M. Brémond, which might be thus stated: 1. In a mixture of several vapours derived from substances having no solvent action on each other, the vapours act towards each other as permanent gases. When the temperature of the mixed vapours is reduced, the vapour having the lowest tension is precipitated from the other as from a permanent gas; a portion of the vapour having the lowest tension being held in diffusion by the vapours having the highest tension, till it reach the point of condensation, when the whole is condensed together. 2. In a mixture of several vapours derived from substances which dissolve each other in all proportions, when the temperature is reduced, a portion of the whole of the vapours is simultaneously condensed, the quantity of each being dependent on the difference in tension between the vapours and the relative proportions in which they are present. 3. A mixture of several vapours derived from substances which only partially dissolve each other, on being reduced in temperature follows in part the laws previously given, dependent on the proportion of each vapour present.

The above laws are verified in an endless series of processes. For instance, in the distillation of coal tar and paraffin oil, steam is injected into the distilled fluid, and, the hydrocarbon vapour not being soluble in the water vapour or steam, acts in a manner similar to an atmosphere of permanent gas; the tension of the hydrocarbon vapours being added to that of the steam, the mixed vapours pass from the still to the condenser at a temperature somewhat under the separate volatilizing point of the distilling fluid. The hydrocarbon vapour being held in diffusion by the steam, on the temperature and consequent tension of the mixed vapours being reduced, the hydrocarbon vapours are precipitated or condensed from the steam as from a permanent gas, not a trace of water vapour being condensed till the temperature falls so far as to lower the tension of the steam below that of the atmosphere, when the whole steam and remaining vapours are condensed together.

Again, as an instance of the action of the vapours of substances which are soluble in each other, take the distillation and preparation of absolute alcohol from fermented liquors. The boiling-point or tension of the vapour from the mixed alcohol and water is intermediate between the two tensions of the separate vapours, and, as a matter of course, varies with the proportions in which the liquids they are derived from are present in the still; but however small the quantity of alcohol, and however large the quantity of water, or *vice versâ*, alcohol and water will simultaneously distil together. On the tension of the mixed vapour being reduced in the condenser, the water vapour, in accordance with its lower tension, is first precipitated, but it invariably carries with it a small quantity of alcohol, dependent upon the relative quantity of vapour of alcohol and water present. Hence the reason why two separate fluids, which are soluble in each other, require such a number of fractionatings before they can be obtained pure, and why, in some cases, substances having a stronger affinity for one of the soluble substances have to be employed to remove the last traces—as in distilling alcohol over quicklime, which has a strong affinity for water, to remove the last traces of that substance. Those two processes illustrate the difference in the action of vapour *per se* derived from substances which do, and from those which do not, dissolve each other, and are sufficient to show that vapours, when mixed, affect the tension of each other. But perhaps the best illustration of the application of the laws relating to the tension of mixed vapours, when a very complex mixture of gases and vapours are to be arranged in groups, and separated by means of condensation, or the lowering of the vapour tension, is given in the condensation of coal gas.

The crude gases and vapours, as they enter the hydraulic main, may be divided into two groups—those substances which the manufacturer desires to retain as permanent gas, and those which he wishes to eliminate. To the former group belong the hydrocarbon gases and vapours of the volatile hydrocarbons; to the latter, the denser hydrocarbons and sulphuretted hydrocarbon compounds, which are solvents for the former in nearly all proportions; also water vapour, ammonia, carbonic acid, sulphuretted hydrogen, &c. The gas manufacturer has learned that to very suddenly cool his crude gases and vapours he reduces the illuminating power of the gas, the reason being that when the whole of the vapour tensions are reduced simultaneously and quickly, the solvent action of the denser hydrocarbons is allowed full play, and they therefore reduce the vapour tension of the volatile hydrocarbons absorbed, and remove them as tar. To prevent this action, the gases and vapours are cooled very slowly, in order that the vapour tension of the solvent denser hydrocarbons may be reduced first, thereby causing them to be precipitated at a temperature which will lower their solvent action as much as possible, and allow the gases to retain the vapours of the volatile fluids in diffusion.

But, however slowly the cooling may be effected, it will only modify the solvent action of the denser hydrocarbons to a limited extent. The slow cooling resembles a single distillation of alcohol and water. To entirely separate alcohol and water, it is necessary to subject them to a series of fractional distillations and condensations; and, for a similar reason, to separate the volatile hydrocarbons from the denser, it is necessary that they be similarly distilled and condensed. Mr. Aitken's process for the condensation of crude gas is, as you are aware, based upon this mode of treatment. Careful fractional condensation will only separate the vapours of low tension; the vapours and gases having a high tension, which it is desired to eliminate, cannot be removed by condensation without simultaneously removing the hydrocarbon vapours of high tension, which it is desired to retain in the gas. Other physical or chemical means must, therefore, be employed to eliminate these compounds. Thus water, which has very feeble solvent action on the hydrocarbons, but a powerful affinity for ammonia, is employed to remove that gas. This water may be applied to the gas either in the liquid or gaseous form, as when the steam-scrubber is employed. When used in the latter form, we have again brought into play the law relating to the tension of mixed vapours and gases. Water in the gaseous form having no solvent action on the hydrocarbon vapours, acts towards them as if it were a permanent gas, the hydrocarbon vapours being diffused through the steam in similar proportion to that in which it is through the other permanent gases. Should the mixed vapours of steam, hydrocarbon vapours, and gases be very quickly cooled, the water vapour is in great part instantly precipitated, and the portion of the hydrocarbon vapour which was held in diffusion by it, not having the necessary time to transfer itself to the permanent gas, is also precipitated. Slow cooling allows this exchange to take place, and only the hydrocarbons, due to their limited solubility in water, are precipitated with the precipitated steam-water along with the ammoniacal gas. Here also we have illustrated the enormous effect of the water vapours when their tension is reduced to the liquefying point, causing a very large reduction of the vapour tension of ammoniacal gas or vapour.

The gaseous sulphuretted hydrogen, carbonic acid, and sulphuretted hydrocarbon compounds, being absorbed by hydrate of lime and its salts, the only matter now remaining in the purified gas, not eliminated, is water vapour. As the presence of this water would cause, by its sudden condensation, the precipitation of a portion of hydrocarbon vapour, Mr. Aitken proposes to remove it by the chemical affinity of oxide of calcium, or quicklime, for water; and by thus removing the water vapour at a comparatively high temperature, the hydrocarbon vapours are left in diffusion in the permanent gas.

Admitted, then, that naphthaline is produced only at high temperatures and in the retorts, it is evident that any process which would absorb or dissolve it out of the crude gases, during the process of condensation, would, according to Mr. Henry Aitken's views, obviate any necessity for the employment of a desiccating process, and that it would only be in the event of some form of condensation being employed which would prevent the naphthaline and other hydrocarbons from being removed that a desiccating process would be required.

Now, the process of Mr. Henry Aitken is just such a one. Instead of allowing the tars and gases to cool together, and thereby allowing the tars to absorb the naphthaline, as also necessarily a quantity of the vapours of the other volatile hydrocarbons, he removes the tars proper from contact with the gases whilst hot, and, by a fractionating process of cooling, saturates the gases to the fullest extent with the vapours of the most volatile hydrocarbons; and to enable the gases to retain those precipitable vapours, he dries them by passing them through lime; and, mark the reason why—because he had learned, by experiment and observation, that when watery vapour was condensed and precipitated, a portion of the hydrocarbon vapours which he wished to keep in the gas was simultaneously condensed and precipitated.

Mr. Aitken does not desiccate the gases to prevent the precipitation of naphthaline alone, but from the first he has, to my knowledge, all along held that his process would prove a complete cure for the nuisance of naphthaline deposit; for the double reason that the denser naphthaline would be, so to speak, fractionated to the proper point out of the gases by the improved form of condenser, and there would also be diffused through the gas an extra quantity of the vapours of the liquid hydrocarbons, which act as solvents for solid naphthaline.

In short, the points of difference between the two processes are these:—Mr. Aitken's patented process is founded upon laws, and upon results which have fully verified those laws; while that of M. Brémond, on the other hand, is founded upon what is evidently an error, and for the prevention of that which does not take place—viz., the precipitation of naphthaline, which has been produced synthetically, from certain constituents in the gas, by the agency of the heat given out by the condensation of aqueous vapours.

Had M. Brémond given more careful thought to the extract of the report to the Board of Trade by the London Gas Referees, which he gives in his paper, it would have saved him from committing the blunder he has made, for it is there pretty clearly indicated that the presence and mode of condensing aqueous vapours from coal gas has an effect upon the condensing point of the other hydrocarbon vapours suspended in the gas. And a perusal of Mr. Aitken's specification would have shown him that he was committing a further blunder in attributing to Mr. Aitken any desire to lay claim to the discovery of the fact that the presence of aqueous vapour in gas reduced its illuminating power, the fact having been known long previous to the date of the report of the London Gas Referees, that water vapour reduced the illuminating power not only in the manner alluded to by "Selenium" in your issue of Dec. 11, but also by its undergoing decomposition during the combustion of the gas; the oxygen of the aqueous vapour combining with, and consuming, the carbon of the hydrocarbons at a temperature below that of incandescence, and thus also reducing the luminosity of the gas. Mr. Aitken makes no such claim. What he does claim to have discovered, or at least to have been the first to apply, is the fact that by desiccating gases they will sustain being exposed to a much lower temperature without a precipitation of the hydrocarbon vapours taking place.

WM. YOUNG.

Clippens Oil-Works, Paisley, Dec. 19, 1877.

THE REFEREES STANDARD BURNER FOR TESTING CANNEL GAS.

SIR,—In your issue of Nov. 27 last gauges are given of a standard burner for testing cannel gas, made, I suppose (though this is not stated), by the Chartered Company, which is of 20-candle illuminating power.

These gauges, though issued by the London Gas Referees for gas-testing purposes in their own district, will doubtless be taken, coming from so high an authority, as a guide for manufacturing test-burners, and for testing cannel gas of the London quality in districts far removed from that City. For these, and other obvious reasons, it is important that the instructions should be intelligible and reliable. As they appear, looking from my stand-point, lacking in these features, I venture to ask the favour of your inserting the following remarks, which would have been penned much sooner, had not other pressing duties engaged my attention.

In order that I may be properly understood, permit me to quote the particulars given, which are as follows :—

Cannel Gas.

	Inch.
External diameter of top of stem	0·31
Internal diameter of stem	0·17
Width of slit	0·02
Depth of slit	0·15

I assume that the gauges here given are intended—first, as a standard that meets the requirements of the Acts under which the Chartered Company's cannel gas is tested, one of these conditions being that the gas should be consumed at the rate of 5 feet per hour, at 5-10ths pressure; and, second, as a guide to manufacturers who may have the burners to make, and to those who may have them to use.

The particulars regarding the depth of slit are indefinite, and do not convey a clear idea as to whether the depth of slit has been gauged from the top of the "external stem" or the top of the internal stem, and one can only assume that it is the former which is intended, from knowing that the depth of slit given, if cut through the internal stem, would consume nearer 10 feet per hour than the 5 feet required. But to gauge the depth of slit from the outside, when it is the depth cut through the "internal stem" that is required, is not the proper mode of procedure, even if a given depth of slit, gauged from the outside, always carried with it a given depth of slit through the internal stem. But there is no such relationship. Though the depth of slit gauged from the outside may be the same, the consuming power of burners can be varied, and is varied in the ordinary course of manufacture, to an enormous extent, by varying the thickness of material between the *top* of the "internal" and "external" stems. There are other particulars, which it would be too tedious to mention here, which materially vary the consuming power of burners, showing exactly one outside depth of slit; and seeing there is nothing to be said in favour of gauging from the outside, the "internal" stem can alone be considered the correct part to gauge for depth of slit. To what depth the "internal stem" is slit in the standard burner above particularized can only be assumed; but, allowing the same thickness of material between the top of the "internal" and "external" stems as is given for the sides, there will be a slit 0·08 inch in depth. This, with its width, 0·02 inch, through the internal stem, which is 0·17 inch in diameter, will make a bat's-wing burner that will consume at 5-10ths pressure 7·14 feet per hour of 16-candle gas, and 6·86 feet of 20-candle gas, such as is made by the Chartered Company, instead of the 5 feet that I suppose is required to be consumed in testing that Company's gas.

The width of slit given, 0·02 inch, will cause a 20-candle gas-flame to smoke freely, and will not yield the most light from the gas consumed, and no maker who knows his business sends out a burner for that quality of gas with that width of slit.

If my remarks are based on a good foundation, the gauges given will require revising; if not, I shall be glad to have these remarks revised and put right.

Leeds, Dec. 21, 1877. GEO. BRAY.

Legal Intelligence.

BACUP PETTY SESSIONS.—WEDNESDAY, DEC. 19, 1877.
(*Before Mr.* HOYLE, *Mr.* SUTCLIFFE, *and Mr.* MADEN.)

NON-PAYMENT OF LIGHTING RATES.

Mr. *James Barcroft*, of Edgeside, was summoned by Mr. Clegg, secretary to the lighting inspectors of Newchurch, for the amount of his rates upon two mills and his house.

Evidence having been called to prove that all the requirements of the Act had been complied with,

Mr. *H. Stott*, the collector, said that the defendant objected to pay because there was a road near to where he lived not yet lighted up, and said that when that road was lighted he would pay.

Mr. *Clegg* said that he and Mr. R. W. Munn had waited upon the directors of the Rossendale Union Gas Company as to the lighting of the road in question, and they had said they could not promise to lay the mains this season, as they were so busy in Rawtenstall and Clough Bridge, but next spring they would lay them.

Service of the summons having been proved, defendant not appearing, the magistrates made an order for payment.

An operative, named *Trickett*, was summoned for a rate made at the same time, amounting to 5*s.* 6*d.* The rate was for a year, but it was proved that the defendant had only lived in the house five months, and that the defendant's proportion would only be 2*s.* 3*d.*, for which amount an order was made, the magistrates remarking that, as there had been an error on the part of the overseer, the defendant could pay the rate without the costs.

CARDIFF BOROUGH POLICE COURT.—FRIDAY, DEC. 28, 1877.
(*Before* Mr. R. O. JONES, *Stipendiary Magistrate.*)

FAILURE OF A PROSECUTION OF A GAS COMPANY FOR ALLEGED DEFICIENCY IN ILLUMINATING POWER OF GAS SUPPLIED.

The Cardiff Gaslight and Coke Company were summoned by the Cardiff Urban Sanitary Authority for supplying gas of a less illuminating power than was required by the 17th section of their Act of 1870.

Mr. INGLEDEW, who appeared to prosecute, said the 17th section of the Company's Act prescribed that, unless prevented by unavoidable cause or accident, or during any necessary repairs, all the gas supplied by the Company should be of such quality as to produce from an Argand burner, having 15 holes and a 7-inch chimney, and consuming five cubic feet of gas per hour, a light equal in intensity to the light produced by 14 sperm candles, of six to the pound, burning 120 grains per hour. For the benefit of the public, it was provided by section 19 of the Act that "it shall be lawful for the Cardiff Board of Health, and any Local Board of Health within the limits of this Act, to appoint a competent person, not being a member, officer, or servant of such Local Board, from time to time to make experiments as to the illuminating power and purity of the gas by means of any of the experimental meters and other apparatus before mentioned, and he may at any hour in the daytime, and not later than eight o'clock in the afternoon, either with or without the concurrence or presence of the manager or any other officer of the Company (but such manager or officer may be present if he so require), make experiment of the illuminating power and purity of the gas as before mentioned; and whenever such experiment shall be made at the Company's works, the Company and their officers shall afford all reasonable facilities for the making of such experiments, and if it shall be proved to the satisfaction of any two justices, not being shareholders of the Company nor members of such Local Board, after hearing the parties, that the illuminating power or purity of the gas supplied by the Company did not, when so tested as aforesaid, equal the illuminating power or purity by this Act prescribed, or that the Company or their officers refused to afford such reasonable facilities as aforesaid, or hindered or prevented the making of such experiment, in any such case the Company shall forfeit such sum, not exceeding £20, as the Justices shall determine." The cost of the proceedings, by section 20, was left in the discretion of the Justices.

The MAGISTRATE: There does not appear to be any notice of the testing required to be given to the Company.

Mr. INGLEDEW said no notice need be given of intention to test, when the testing took place at the works of the Company. If the testing took place at the Town Hall (which might be), then notice had to be given. In this case the testing did not take place at the Town Hall and therefore no notice was necessary. By section 18 it was enacted that "the Company shall, within six months from the date of the passing of this Act, cause to be erected and maintained in good working order, at each place of manufacture of gas, or station from whence the same shall be supplied, an experimental meter with an Argand 15-hole or other approved burner, and a seven-inch chimney, capable of consuming five cubic feet of gas per hour, with other necessary apparatus for testing the illuminating power and purity of all the gas of the Company; and it shall also be lawful for the Local Board of Health for the corporate district of Cardiff, at their own expense, and for the sole use of the said Local Board, their officers and servants, and the persons from time to time appointed by the said Local Board to test gas as hereafter mentioned, to erect and maintain at the Town Hall, Cardiff, or other convenient place near or adjacent thereto, a like experimental meter and other necessary apparatus for the purpose of testing the illuminating power and purity of gas as aforesaid." In this section they met with the expression, "or other approved burner," which did not occur in section 17, where the statute provided the standard of illuminating power. The standard was defined clearly by that section, and the means of ascertaining it were set forth. Possibly the Company might endeavour to show that, although on the present occasion the gas was not up to the standard of the illuminating power required when tested by a 15-hole Argand burner, yet they had provided another burner by which the gas would produce illuminating power in excess of that which was required by the statute. In this particular case the test was taken by a 15-hole Argand burner, such as was mentioned in the 17th section. He took it, therefore, that if he satisfied the Court that the illuminating power, as tested by that burner, was not equal to the illuminating power required by the statute, then the Company would be liable for not having complied with the provisions of the statute. In the present case Mr. Thomas, instructed by the Cardiff Urban Authority, went to one of the places of the manufacture of the gas, Grangetown, on the 23rd of November, and there tested its illuminating power, the result being that it was found to be below the standard prescribed by the 17th section. He (Mr. Ingledew) proposed to call Mr. Thomas to prove this fact, and he would then ask in the interest of the public, for the infliction of such a penalty on the Company as would induce them in future to comply with the provisions of their own Act.

Mr. *J. W. Thomas* deposed that he was an analytical chemist, and had studied gas analysis. He was appointed by the Cardiff Urban Sanitary Authority to make experiments as to the illuminating power of the Cardiff Company's 'gas. On the 23rd of November he made experiments at the works of the defendants at Grangetown. He tested the gas at the time prescribed by the Act, before eight o'clock in the evening, by means of an Argand burner having 15 holes and a 7-inch chimney, consuming 5 cubic feet per hour. He had performed the test with the same meter previously; it was provided for the purpose of testing. The Manager of the Grangetown works (Mr. Evans) was present during the experiment, watched witness's readings, and was perfectly satisfied with them. Witness found the gas below the illuminating power prescribed (14 candles); the average of his tests showed it to be 13·63, which would make the difference in illuminating power rather more than a third of a candle.

Mr. NORRIS (who appeared for the Gas Company): Are you the Public Analyst appointed by the Urban Authority of Cardiff?

Witness: No; appointed by the Corporation.

And the Corporation are the Urban Sanitary Authority? You are the Public Analyst appointed by the Cardiff Corporation?—I believe by the Town Council.

At a salary?—Yes, at a salary—£100 a year.

Your appointment is made under the Sales of Food and Drugs Act, 1875?—Yes.

When were you appointed by the Cardiff Urban Sanitary Authority as Gas Inspector?—In October, 1876, I believe.

The MAGISTRATE: Then your appointment as Public Analyst was before?—I was provisionally appointed Public Analyst before.

Mr. NORRIS: You are paid a separate and distinct salary, I believe, as Gas Inspector?—Recently I have been.

The Corporation of Cardiff are the Cardiff Urban Sanitary Authority?—I should think not.

In what respect do they differ?—I cannot say.

Mr. INGLEDEW: It is a question of law; he cannot tell. I object to your taking an answer from him on that subject.

The MAGISTRATE: Are they a committee of the Corporation?

Mr. NORRIS: By the Act of Parliament of 1875 the Corporation and the Local Board of Health are made the Urban Sanitary Authority.

The MAGISTRATE: If that is the case, the Court will take notice of that.

Mr. INGLEDEW objected to the question being put to the witness, as it was a question of law.

Mr. NORRIS accordingly withdrew the question, and proceeded to argue that the witness was not a competent person to test the gas, as he was a servant of the Corporation. The Corporation must spend a little more money, and employ somebody else.

Mr. INGLEDEW did not agree with Mr. Norris's law, and argued that the Corporation and the Urban Sanitary Authority were different bodies for all practical purposes, having different funds to deal with.

Mr. NORRIS contended that the intention of the Local Act was clearly that the person appointed to test the gas should be somebody utterly and entirely distinct from the Corporation. The 18th section of the Act gave the Cardiff Urban Sanitary Authority power to erect and maintain for their exclusive use a meter for testing purposes at the Town Hall.

Mr. Ingledew maintained that the two bodies, the Corporation and the Sanitary Authority, had different and distinct offices, and different funds to deal with. Suppose the Town Clerk were to bring an action against the Local Board of Health, he, being an officer of the Town Council, must necessarily be nonsuited.

The Magistrate said it seemed to him to be this: An officer was appointed by a body having a certain name, who, under another name, were really the same set of people. They called themselves black to-day and white to-morrow.

Mr. Norris, quoting from the Cardiff Improvement Act, said the Corporation were there described as the Sanitary Authority for the borough.

Mr. Ingledew repeated that the two bodies had to perform different functions, and to deal with different funds.

The Magistrate: I have no doubt, looking at the spirit of this Act, that Mr. Thomas is, for these purposes, an officer who ought not to have taken the test. Therefore, unless you have any other evidence to produce that the gas was of bad quality, I must dismiss the case, with costs.

Mr. Ingledew said he had no other evidence to bring forward.

The summons was therefore dismissed.

Miscellaneous News.

ECONOMICAL USE OF COAL GAS.

On Wednesday evening, the 12th ult., Mr. Samuel Hunter, C.E., Engineer and Manager of the Salford Corporation Gas-Works, delivered a lecture, in the Salford Town Hall, on "Coal Gas: Its History, Manufacture, and Economical Use."

The Mayor (Alderman Walmsley) occupied the chair, and, in introducing the lecturer, said that during the comparatively short period Mr. Hunter had been manager of the Salford Gas-Works he had done more for the profit of the borough than had been done for many years in the past. Although Mr. Hunter found things in a very unsatisfactory state, he had managed his department so well as to give them a better gas at a cheaper price, and bring in the Corporation a better return. He must be a clever man who could not only give them a better article, but supply that article at a cheaper rate. The Corporation had rightly reckoned Mr. Hunter's services. No doubt he would that evening show them many interesting things in the process of manufacturing gas, and no doubt also the audience would be much better pleased to hear what Mr. Hunter had to say, and to witness what he had to show them, than to listen to any further observations from him.

Mr. Hunter, after alluding to the discovery of gas, and the prejudices which existed against its use in the middle ages, said that a little over 200 years ago, in 1659, a Mr. Thomas Shirley, of Wigan, had his attention drawn to a ditch about a mile on the way to Warrington, the water of which was inflammable, and was considered one of the wonders of the world. Being an intelligent man, he made numerous exact observations, and sent an account of the whole matter to the Royal Society. It was not the water that was inflammable, but doubtless the then unaccountable production of flame came of the carburetted hydrogen of the underlying coal-field. The introduction of gas had given a thousand important impulses to our national industries. Like many other good physical blessings, it had proved itself also a capital moral agent. It had helped even to reduce crime, and Councillor Brown, speaking some time ago in the Council, gave it as his opinion that the more light we had in the streets the less crime they would have in the police courts. It was Winsor, a German or Frenchman, who started gas lighting in the Metropolis, but so little was the invention then understood and believed in by those who had not seen it in force, that even great and wise men laughed at the idea. "How could there be light without a wick?" said a member of Parliament, when the subject was brought before the House. The first shop lighted in London by the new method was Mr. Ackermann's, in the Strand, in 1810 or 1812, and one lady of rank was so delighted with the brilliancy of the gas-lamp on the counter, that she asked to be allowed to take it home in her carriage. Almost immediately after the splendid illumination of the Soho Steam-Engine Works, a move in favour of gas was made in Lancashire. At the close of 1804 a course of lectures on gas, by the celebrated Dr. William Henry, attracted the attention of some of the enterprising men of Manchester, and in a short time an energetic beginning was made by the late well-remembered Mr. George Augustus Lee. Mr. Lee was junior partner in the celebrated old firm of Salford cotton spinners, which, beginning in 1804 as Phillips, Wood, and Lee, shortly afterwards became simply Phillips and Lee. Their works, called the Salford Cotton Mills, counted as 52 and 53, Chapel Street, and for a long period were the largest in the district. At the present time the building was used as the bonding warehouses. By 1816 the current of public opinion had turned in favour of gas, and towards 1820 gas lighting became general all over England. In the latter year gas-works for the supply of the public were set on foot in Salford by a private gentleman, a Mr. Appleby. These were purchased in 1831 by the Police Commissioners—a local authority preceding the Corporation—for £6000. The capital invested in the Salford Gas-Works at the present time was £350,000. His (the lecturer's) notice of what Manchester had done must be taken as read, beyond stating that Manchester rapidly followed in the wake of Salford, one of the first places lighted being Birley, Hornby, and Co.'s mill, in Cambridge Street. After explaining, by means of diagrams, the method of manufacture, Mr. Hunter said that the distribution of gas was only second in importance to the manufacture. The gas having been made, purified, measured, and stored, the next object was to give to each and every consumer as much as he desired. He might here name one very important item, the leakage and loss of gas, or the difference between the measurement when made at the works, and the quantity paid for by consumers. This difference had now reached 85 million cubic feet per annum in Salford, and Salford was no exception to the general rule. This loss arose from causes easy to explain. The distributing plant was very extensive. The Salford district was a very wide one, extending nine miles in one direction from Lamb Lane, and the extent of the large main-pipes laid down in the streets and principal roads was between 160 and 170 miles. A matter of importance to the consumer was the meter, which indicated at the end of each quarter how much he had to pay. The measurement of gas by meter was quite as simple and as exact a process as that of the measuring of ale or porter. Two kinds of meters were in use—the wet meter and the dry meter. A meter correctly made was, within a reasonable margin, perfectly reliable. In order, however, that neither the maker of the gas nor the consumer should become a sufferer through want of accuracy in the measurement of the gas, an Act of Parliament stepped in. The per centage of variation that was to count in favour of either maker or user was fixed by statute. A perfect line was prescribed, but it was utterly impossible that any meter, the work of mortals, could always and infallibly keep true to it. The Act, therefore, required that meters should be so made as not to work at all, unless so accurate as never to show more than 3 per cent. against the consumer, or 2 per cent. against the maker. Having minutely explained the construction of meters, the lecturer said a dry meter might be perfect as far as comparative perfection went, and might be preserved in good order for a length of time; but the balance of advantages was in favour of the wet meter, and the only solid reason why the dry one was preferred by some people was that it gave no trouble in connection with the water, and, in a certain limited sense, was a little cleaner. Neither of them was more blameworthy than the other, in regard to the "jumping" of the gas flame which sometimes occurred. He had endeavoured to point out the truth of what was often doubted—the reliableness of the measurements made by the gas-meter—and he wished the consumers to understand that an overcharge was next to impossible, and that, whenever errors did arise from the imperfect working of the meter, they told more against the gas maker than the consumer. Having illustrated the method employed in testing the amount of light diffused by gas, he said that every one might feel assured that all the statements made by gas men as to the illuminating power of gas were made upon careful experiments, and that every one of them could be demonstrated to be indispensable. With regard to the comparative value and cost of gas-light in relation to the light furnished from other artificial sources, it was obvious that the value of gas to the consumer must be exactly in the ratio of its power to illuminate. Various materials were from time to time loudly vaunted as superior to gas for domestic purposes, particularly the cheaper kinds of oils, and that they were less expensive. People fell into the error of supposing that oil, because it burned so prettily when just lighted, and cost so much less to buy, was therefore better than gas. A greater mistake could not possibly be made. It was a delusion that oil was cheaper than gas. To get a flame from oil equal in illuminating power to a jet of Salford gas burning five cubic feet an hour, the difference against the oil was no less than 60 per cent. To put the matter in exact figures, a pint of oil burning for six hours, and giving a light equal to a flame of gas consuming at the rate of 5 feet per hour, cost 3½d., whereas the six hours consumption of gas would cost only 1½d., or 4-10ths of what was paid for the oil. Another frequent act of popular self-delusion was to suppose that gas must needs be cheaper when the price paid for it was lower. Price was no criterion as to the value of gas, unless the illuminating power was taken into consideration. In Salford the Corporation gave the public a better quality of gas than they would get in various other towns, and perhaps for less money. When gas was poor it was necessary to use more of it, so that in the end the cost added up to much about the same thing. To the consumer no point would be more interesting than the mode in which gas could be employed to the greatest advantage, which question involved primarily the consideration of the best kind of burner. Many consumers, through the use of ill-contrived burners, sacrified no less than 20 per cent., and even 40 and 50 per cent., of the illuminating power of their gas, and then charged the manufacturer with supplying an inferior article. In Salford the Gas Committee told the public, and with perfect truthfulness, that out of a certain volume of the gas they sold there was involved a light equal to that of 20 candles, and any one might satisfy himself that it was so by visiting the photometer-room at the gas-works. What, he might ask, constituted a good burner? It must be so constructed that the supply of air was regulated. If sufficient air could not be obtained the gas smoked—that was, the solid particles of carbon did not get sufficient oxygen—and if too much air were supplied, the particles of carbon were burned too rapidly. The Argand burner was the best for illuminating purposes, the supply of air being regulated to the quantity of gas consumed. Whatever the shape of the burner or the width of the aperture, it was essential, in order to obtain the full amount of light, that combustion should take place, at the point where the gas first inflames, at a minimum or inappreciable pressure. Every one who was disposed to complain of a poor light should look into this matter, and ascertain how far it might be owing to bad burners. He might add that, in Salford, through the use of inferior descriptions of burners, consumers lost, upon an average, 33 per cent. of the light their gas was able to communicate. But all the blame should not be laid perhaps upon inferior or bad burners. Many people wasted their gas by allowing too great a pressure, whilst others used globes of a kind that impeded the light. With regard to the tricks imputed to gas managers, he said they were altogether groundless. A common charge was that air was pumped into the gas so as to dilute it, and thus cheat the consumer. Where such a notion could come from it was difficult to imagine, unless from some fancied analogy of gas with milk, and its dilution with water. In the Salford Gas-Works they had no "cow with an iron tail." To pump air into gas would be absolutely to destroy it as regarded its fitness for lighting purposes. In conclusion, the lecturer said that coal gas was unquestionably one of the greatest levers of modern civilization. It was impossible to look around and fail to see everywhere some illustration of the unspeakable good it had conferred on mankind. He doubted if its boundless capacity for usefulness was yet comprehended, or to what beneficent purposes it might be applied. They knew to some extent what it had already done for our manufactories and workshops, and our homes, but at present they could not say how much further it might go to foster or assist trading purposes by driving our machinery, or to what extent Winsor's wishes or imagination might be realized by the superseding of fire-grates and the abolition of fire-irons in our homes. How loudly the lover of gas complained in case he did not get all he desired, and his fondness for the illuminating agency often caused him to use it extravagantly. Not only could the gas manufacturer claim credit for the beautiful light so useful and so luxurious, but he was the producer of that so-called nasty, dirty tar from which the chemist extracted those beautiful aniline colours—mauve, magenta, and others—the adornments of female apparel, which in their beauty adorned the beautiful. From the distillation of coal we had the gas to give warmth or as a fuel for cooking purposes, or to drive our machinery, or the light to cheer and refresh, which made a "sunshine in the shady place;" we had also the sulphate of ammonia, which was of great value to farmers, and the liquor so useful to washerwomen. What more should he say for gas and its application to all practical purposes? The temple of our country's prosperity found in this useful product the "headstone of the corner;" it yielded precedence to no mechanical agent. We had our telegraphs, our steam-engines, our railways and canals; but without gas to illuminate, all other agencies must be comparatively in darkness. The great work of our Almighty Creator was without "form and void" until he gave the crowning command, "Let there be light." Let us rejoice that our business and home, yea, life itself, had been made more enjoyable by the practical application of gas.

At the close of the lecture a cordial vote of thanks was given to Mr. Hunter, and a similar compliment was paid to the Mayor for presiding.

Exeter Water Company.—At a meeting of shareholders, last Wednesday, it was agreed to accept the offer of the Town Council, and the Directors were empowered to complete the sale of the undertaking to that body.

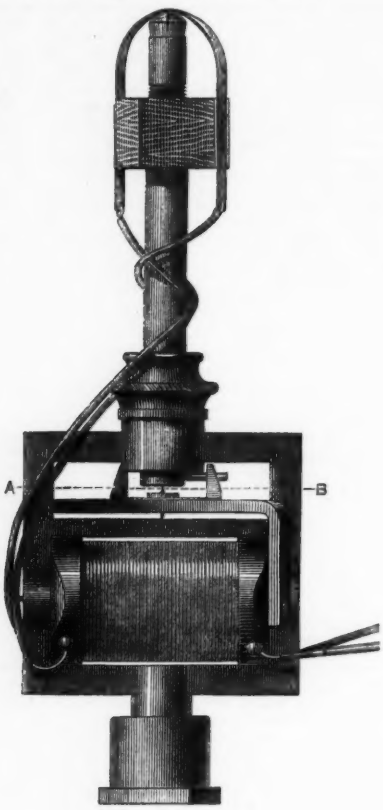
Presentation to Mr. Charles Farrand.—The officers and other *employés* of the Croydon Gas Company have presented to Mr. C. Farrand a handsome silver cup, bearing an appropriate inscription, on the occasion of his retirement, through illness, from the position of manager of the Company, which he had held for upwards of 21 years.

LAMP LIGHTING AND EXTINGUISHING BY ELECTRICITY.

The accompanying engravings exhibit a front elevation and plan, through the line A B, of an apparatus devised by Mr. St. George Lane Fox, the object of which is to enable any desired number of public or other gas-lamps to be lighted or extinguished simultaneously.

Some months ago Mr. Fox obtained permission to test the merit of his invention upon a number of lamps at the Fulham station of The Gaslight and Coke Company, and has done so with results so far satisfactory that we believe the experiment will be continued during the whole of the present winter.

The means whereby the inventor effects his object consist, in the first place, in connecting together the lamps to be operated upon by means of insulated metallic wires, so that an electric current, generated at one point or station, can act simultaneously upon every lamp through the instrumentality of the apparatus here exhibited.



ELEVATION.

PLAN THROUGH A B.

This apparatus consists chiefly of a soft iron core, around which is a coil of insulated wire, thus forming an electro-magnet. The wire of this electro-magnet forms part of the electric current by which the lamps are connected. Around this primary coil is wound a secondary coil of fine wire of much greater length. Above these coils is a permanent steel magnet, free to turn on a vertical axis. These magnets are carried in a small rectangular metal framing, cast or made with a hollow core, and having a cylindrical portion at top and bottom, the lower one being screwed upon the gas inlet-pipe which supports the apparatus, and the upper one receiving the stopcock. This cock is composed of a brass tube, having two openings corresponding with passages on the opposite sides of the rectangular frame. The plug of the cock is made with a very slight downward taper, having two apertures or ways corresponding with the openings in the tube, and is hollowed out in the middle. When the gas is turned on, these apertures come opposite the openings, thus giving a free passage for the gas from the inlet-pipe through the two sides of the rectangular frame, and into and through the plug. The plug is supported on the point of the pivot on which the permanent magnet swings, so that very little power is required to turn it. The magnet itself has cast upon it two projecting pieces of metal and the lower end of the pivot on which it turns, rests in a steel step supported by a small wooden beam secured to a wooden bobbin at each end of the induction coil. The primary wires form part of the circuit by which the lamps to be lighted or extinguished simultaneously are connected. One end of the secondary coil is connected to an insulated wire leading to the gas-burner, where it terminates in a platinum point; the other end is connected to the rectangular frame, or to any other metallic part of the apparatus, so as to be in metallic connection with the burner. This insulated wire passes through an earthenware support fixed to the outlet-pipe.

The action of the apparatus is as follows:—Upon an electric current from a magneto-electric machine, or other suitable apparatus, being sent through the circuit which connects the whole series of lamps, the soft iron core in the apparatus attached to each lamp becomes magnetized, the effect of which is that the permanent magnet is caused to turn on its axis. When it has made about one-third of a revolution the projections thereon strike against a pin, which passes through the bottom of the plug of the cock, so that the plug turns with the magnet for the remainder of its movement, and thereby turns on the gas. The ignition of the gas is effected as follows:—One end of the line having been connected to one of the armatures of a condenser of very large surface, the condenser is charged to an electro-motive force of several thousand volts or units by means of a Rhumkorff coil. The other end of the line is connected with any suitable mechanical arrangement, by which, when it is desired to ignite the gas, contact is made with the other armature, and then instantly broken. A powerful current is thus set up which ceases abruptly, the result being that a secondary discharge takes place at each burner, the lamp being thereby ignited.

When it is required to extinguish the lamps a current from the magneto-electric machine is again sent through the circuit, but in an opposite direction. The permanent magnet of each lamp is thereby caused to return to its former position, and in doing so it again acts on the pin, and turns off the gas.

THE FAILURE OF THE GASHOLDER-TANK AT MIDDLESBROUGH.

By Mr. JOHN CHATTO.

[The substance of a Paper read before the Cleveland Iron Trade Foremen's Association.]

Having been requested to read a paper before this Association, I thought I could not do better than direct your attention to a recent engineering work undertaken in this town, which has been, and I believe still is, a source of great anxiety to the parties directly concerned—viz., the construction of the new gasholder-tank for the Corporation of Middlesbrough. This tank is 183 feet in diameter and 30 feet in depth. I may mention, for the information of those who are not acquainted with the particulars, that the wall of the tank was completed for some 20 feet in height when the internal excavation for forming the cone at the bottom of the tank was commenced. It was at this time that the wall collapsed, causing a row of adjacent houses to give way, so as to render them unsafe for habitation, some of the cracks being as much as 6 inches wide. Since the suspension of the works the excavation has filled with water to within a few feet of the top. In the months of March and May, 1876, Mr. Cail, of Newcastle, and Mr. Livesey, of London, were consulted as to the best mode of repairing the damage, and carrying on the work successfully.

With respect to the damage done by the failure of this tank, and the responsibility arising therefrom, it is not my intention to say anything. I propose simply to deal with the question from an engineering point of view. And first with reference to the site of the tank. The position chosen for its erection has several points to recommend it. It offers facilities for receiving and delivering materials by rail, in the event, at some future time, of its being deemed advisable to erect a retort-house near the spot. In a sanitary view also, the selection is well made, as in this locality it is not likely that a superior class of houses will ever be erected there. In the third place, as it is near that part of the town which is to be supplied with gas, the cost of mains will be reduced to a minimum. Fourthly, it is well adapted for utilizing the ascensive power of the gas, thus avoiding the necessity for heavy pressure at the holder, and reducing the consequent loss by leakage. And, fifthly, the cost of the land was less than any other that could be bought suitable for the purpose.

Geological Features of Middlesbrough.—The town of Middlesbrough may be considered as being a miniature peninsula, being surrounded on three of its sides by the River Tees. The soil is formed from drift of the recent period, there having been found, during the excavation at the site before mentioned, antlers, sea shells, and the frontal part of a human skull.

This formation, I believe, has accumulated from two different sources—viz., that on the north-east side from the flow of the tides carrying with it sand from the sandy cliffs and shore, which are very prominent at the mouth of the river, while that on the west side has been derived from the superficial waste of the adjacent hills, caused by the heavy rains, and which has been carried by the current, and deposited at this particular spot. The river at this part is shaped like the letter V with the point rounded, the current at Newport running east, at which place it abruptly changes and runs due north. Thus nearly all the sediment brought down is deposited upon the Middlesbrough side, while the encroachments are at Newport and Haverton Hill. At the latter place the river again suddenly changes its course, and runs in a south-easterly direction until it reaches the dock entrance channel, and from that place to the bar may be considered as the mouth of the river. The sediment carried by the tides is also deposited upon the Middlesbrough side. It will be readily understood from this description that if the river had been left to its natural course its position would have gradually shifted still more, by encroaching and forming deep water on the Haverton Hill side, while the channel at the Middlesbrough side would become shallower, being destined eventually to be converted into land. The river at this point may in all probability have been nearly straight at one time, and we may attribute its present course to the lias formation, which is seen at Boulby Cliffs to great advantage. The three divisions—viz., the upper, middle, and lower lias—are all exposed to view, and traverse the coast as far as Huntcliff, near Saltburn, at which latter place they disappear, but are found again opposite Redcar, and may be seen at low water. From this point they run across the mouth of the river, where workmen, some time ago, were employed to blast lias away. From this point up the river the formation is broken, so that there is no regular stratum under the Middlesbrough drift; for the lias, as seen at Boulby, passes away into the interior of the country, which it traverses in a south-westerly direction, and at the same time rising considerably. Its elevation at Eston Nab is about 600 feet. I may here mention that it is from the middle division or Marlstone series of this lias formation that the ironstone is obtained in such great quantities.

It will now be understood that as the tides gradually deepened the river mouth, the channel also gradually shifted towards the north side, while the south side was protected by the escarpment of the lower lias before mentioned, which dips to the north side, the water always encroaching on those parts which offered the least resistance. From these considerations, I believe that the formation of the Middlesbrough drift is due to the shifting of the river mouth, caused by the lias formation at this place. We will now examine the Middlesbrough drift as situable for heavy foundations.

The greatest depth attained is at Bolckow, Vaughan, and Co.'s works, the boring of which presents the following strata:—

		Feet.
Mud, loamy sand, and clay		58
Rock mixed with clay		12
Rock mixed with gypsum, including two beds of gypsum of 2 feet and 6 feet respectively, also the new red sandstone		69
Salt	Very dark 4 feet 1 inch Rather „ 39 feet 11 inches „ light 9 feet Very „ 47 feet	100

The salt is supposed not to have been bored through. The above strata cannot be taken as a guide for foundations at any other part, for it is well known to local engineers that the drift varies continually, and where the engineer has failed to gain a good foundation for his work in one place, he has found it in another not more than 30 or 40 yards distant. Piles have also been driven to a great depth without success; therefore, the only reliable information is that gained either by sinking staples or boring.

With reference to ground at site, Mr. Cail had a staple sunk to a depth of 56 feet below the surface, the strata of which are as follows:—

	Feet.
Clay	4
Loam	10
Peat	4
Clay and vegetable fibre, and which we will call, for convenience, vegetable clay	38
Giving a total in feet of	56

Concrete Gasholder-Tanks.—Concrete tanks, with a lining of brickwork, appear now to be generally recognized as being the cheapest known construction suitable for this purpose. The first concrete, or more properly composite, tanks were constructed with a double brick wall, the space between them being filled with concrete. The next step in advance was to leave out the back brick wall, and in 1874 a tank was constructed at the South Metropolitan Gas-Works, the dimensions of which were 184 feet in diameter and 47 feet in depth, entirely of concrete. Neither brick, iron, stone, nor puddle was used, the interior being coated with a skin of Portland cement to make it water-tight, the foundations being on the London chalk. This tank was completed and filled with water, when it was discovered to be cracked from the top to the bottom, the crack being about one-sixteenth of an inch in width. Afterwards four more cracks appeared in different parts. However, the gasholder was put to work, and has continued so ever since, the loss by leakage of 6 inches in depth of water in 24 hours being supplied from the works. From this circumstance we may come to a conclusion that tanks built entirely of concrete are not to be relied upon. The foundations in this case were on the chalk, therefore no settlement could take place, and the cracks must be attributed to the weakness of the wall.

I have come, then, to the conclusion that tanks with a brick lining are preferable, as the lining can be built forming the inner circle to a nicety, and if built three or four courses in advance, the concrete can be laid with little trouble. The brickwork should be bonded with the concrete at intervals, although this is not thought necessary by some engineers. Taking into consideration that concrete is stronger than brick, this appears feasible; nevertheless, I prefer the work bonded, because the additional security afforded thereby, in case the lining should have a tendency to leave the concrete, covers the additional expense.

In order to strengthen the concrete while new, layers of hoop iron should be laid all round at about every four feet in depth, and, to protect the iron from rusting, it should be bedded in neat cement. It must be remembered that concrete will leak like a gravel bed, and that cement with ever so little sand mixed with it is porous. Concrete with one part Portland cement, two of sand, and four of gravel, or any other suitable material, when properly worked, is stronger than brick and cement, the ratio being about one-third. It requires great care and experience in its manipulation, also a good aggregate, and the selection of a good cement, together with constant supervision; for, of all building materials, concrete seems to be the only one which defies the engineer in judging of its quality by appearance, while the others can be judged by their colour, weight, texture, fracture, and sound.

As the strength of concrete mostly depends upon the quality of the cement, great care and judgment are needed in making a good selection, and amongst the several kinds used for the purpose, Portland cement stands first. It is composed of clayey mud and chalk ground together, and afterwards calcined at a high temperature, after which it is ground to a fine powder. Old cement is preferable, as it increases in strength if kept from moisture. Its resistance to compression is about double that of any other ordinary building stones, being about 336 lbs. per square inch; its tensile strength is 300 lbs., and it should weigh from 115 to 118 lbs. per bushel. Its goodness also depends a great deal upon its fineness, and by a little practice this can easily be ascertained by pressure between the finger and thumb. The colour should be rather of a light-bluish grey; if it is very light there is too much free lime, and if rather dark there is too much clay in its composition. The lime causes expansion, but this may be remedied by exposing the cement to the air for some 24 hours before being used, especially new cements; while in the case of excess of clay, the cement sets more quickly, and is considerably weaker. Of the two evils, therefore, the lime is the less, and it follows that a slow-setting cement is the strongest.

The method of testing for tensile strength is to form bricquets from the cement mixed with as little water as possible, which at the end of a month are placed in a machine made for that purpose. The test for expansion is made by filling a strong glass bottle, without ramming, with the cement mixed as above, and if in 24 hours the bottle is not cracked, it may be passed. The test for fineness it made by placing the dry cement in a sieve of 2500 meshes to the inch, and if 80 per cent. passes through it may also be passed. Too much care cannot be taken in testing the cement, for, if bad cement is used, it is not only useless in itself, but also the money expended on other materials, and labour in connection with it, is completely thrown away.

With reference to the materials used for mixing with the cement, these should be of a porous nature, and, for this purpose, broken clay retorts stand first. Well-burnt bricks come next, and then clean gravel and sand. Particular attention must be paid to the rejection of all materials of a soft and loamy nature, as well as those containing vegetable matter. I think, in the present case, that the slag obtainable at the site may be used with advantage on the score of economy, providing that it is broken into pieces not exceeding 2½ inches, as iron slag, generally speaking, cannot be classed as a porous substance. By reducing the slag to a small size, the cement will be distributed over a larger surface, and thus the few pores and angular shapes that it may contain are utilized, and a homogeneous mass is formed. Layers or packings of large pieces should be avoided, or, if used, the cement should be increased to three parts, and care must be taken to surround them with smaller material, so as to fill up all interstices.

It must also be borne in mind that slag is much heavier than ordinary concrete, the difference being as 1·64 is to 3·37 tons per cubic yard. The ground will have, therefore, this extra weight to bear, and this is a point which requires consideration in the case of weak grounds. It is immaterial whether the water used for mixing is salt or fresh; but the quantity should be as little as possible, being just sufficient to thoroughly moisten the mass, and care must be taken to have a proper supply for this purpose, for if insufficient, the cement will not set properly, and the whole concrete so mixed will be useless. The materials should be thoroughly soaked in water until required for use, and before placing a fresh layer, the previous one should be examined and freed from all foreign deposit that may have collected on it. It should then be made thoroughly wet, and in case the work should be drowned by the trenches getting filled with water from heavy rains, or otherwise, on the recommencement of the work the top should be thoroughly swilled to cleanse it from the deposit of mud which will have collected; the next layer can then be laid.

In laying the concrete, it should not be shot from a height, for by so doing, the heavier parts fall in a heap together, and to a great extent separate the cement from the other parts. It should be gently laid and spread at once, then lightly rammed.

The depth completed per day may be about 9 inches, and should not exceed 12 inches. The work will increase in strength by age. It has been found from experience to be, at 112 days old, as follows:—

Pure cement	increases 36 per cent.
One cement and one of sand	„ 60 „
One cement and four of sand	„ 200 „

By chemical analysis, good Portland cement has been found to be of the following composition:—

Insoluble in acid	33 per cent.
Alumina and oxide of iron	14 „
Lime	50 „
Moisture, &c.	3 „
Total	100 „

Our next consideration will be the cause of failure.

With all due deference to the opinions of Messrs. Cail and Livesey, I am, however, under the impression that the direct cause of failure has not yet been given, and which I now state as my opinion to be entirely due to the drainage of the surface water, and which I will now endeavour to prove. In the first place, I have practically tested the sustaining power of the ground in question, the samples chosen are those taken from between the peat and the vegetable clay; and in order that there shall be no mistake on this head, they are now on the table before you. The testing was conducted in the following manner:—

Estimated weight of the coal depôt building and 4 feet slag foundation, together with slag wall which has fallen = 508 tons.

This weight distributed over an area of 600 superficial feet $= \frac{508}{600} = \cdot 846$ of a ton per square foot.

The slag varies in weight; the piece on the table was taken from the site, and weighs 5 lbs., which displaces 27·55 cubic inches of water; 1 cubic foot of slag will therefore weigh $\frac{5 \times 1728}{27 \cdot 55} = 313 \cdot 6$ lbs.

The sample was then pressed firmly in a perforated cylindrical vessel 4¾ inches deep, the outside being wrapped closely with hemp, which prevented any of the soil from escaping, while it left room for the water to drain off. On the top of this was placed a piece of wood 4¼ inches in diameter, which fitted loosely in the vessel, and on the top of this again was placed a direct weight of $\frac{4 \cdot 125^2 \times \cdot 7854 \times \cdot 846}{144} = \cdot 0785$ of a ton = 175·8 lbs. This being the proportional weight of the building, the following is the rate that the ground sank:—

In 12 hours	⅛ of an inch.
24 „	1 inch.
48 „	1¼ „
96 „	1¼ „
168 „	1⅜ „
336 „	1½ „

After which it appeared to stand for the next fourteen days. If the ground, therefore, had been excavated all round the building to a depth of the bottom of the peat, then by this proportional (4·75 : 48 :: 1·5) the building would have sunk 15 inches. But in this case we have only one side of the building exposed to drainage, caused by the excavation; therefore we have as $\sqrt{600} : 24 :: 24 : 15$; then $\frac{15}{24} = \cdot 625$ or ⅝ inch, and which I have no doubt will be found to be the vertical settlement of the building if measured.

Again, with reference to the cracks in the buildings, taking one that is 6 inches wide at the top, at the first sight the general impression is that the ground has slid away, but on investigation we find that it has done no such thing, for in looking towards the bottom we find that the crack there is only 2 inches wide, and if the same crack be examined to the bottom of the 4-feet slag foundation, I have no doubt that it will be found to diminish to nothing, or nearly so, while the ground will not show any crack. These cracks are, therefore, due to the diminishing bulk of the ground, caused by the abstraction of the surface water, which does not take place equally, but is greatest near the edge of the excavation, and diminishes in the ratio as the square of the distance; therefore the settlement of the ground will be in the form of a parabola.

Referring again to the sample before mentioned, we find that it has reduced in bulk from 4¾ inches to 3¼ inches in depth, thus giving a loss of (4·75 : 1·5 :: 100) = 31·5 per cent. Then the stratum of peat being 48 inches, this is = (100 : 31·5 :: 48) = 15 inches; but taking into consideration the distance that the excavation is from the weight—viz., 15 feet to the building and 30 feet to the crack—we will, therefore, have (30 : 15 :: 15) = 7½ inches, or 15·75 per cent. as the settlement of the ground at the edge of the excavation, which is found to agree exactly with the crack in question, for the top of the crack and the ground between the excavation having been set off to the same radius, the difference of each is found to be equal—viz., the crack is 6 inches wide, and the ground has sunk 6 inches.

The next test was the sustaining power of the water in the peat, the sample, weight, &c., being the same as the above, and was pressed firmly in a cylindrical vessel which was not perforated, and a weight of 224 lbs. being placed on the top, in 30 minutes it sank one inch; the weight was then taken off.

In 7 minutes it rose	⅛ of an inch.
15 „ „	¼ „
2 hours „	⅜ „
6 „ „	⅜ „

after which it appeared to stand for the next seven days.

The next test was to ascertain the quantity of water contained, the sample being the same as the above in every respect, and weighing 2½ lbs., and after being placed on the kitchen chimney-piece for 28 days it was found to weigh 8½ ounces, thus giving (80 : 63 :: 100) = 78·75 per cent. of water. The next is a sample of Linthorp clay, which has been subjected to the same process as the above peat, and has diminished in weight from 3 lbs. to 2½ lbs., thus giving (48 : 8 :: 100) = 16·6 per cent. of water, and is therefore (78·75 : 62·09 :: 100) = 78·84 per cent. better adapted for foundations.

Thus it is clearly shown that the vertical settlement was sufficient to produce damage to the property, supposing the ground not to have moved forward, therefore piling and timbering would not altogether have saved it. I grant that if the part near the buildings had been properly timbered it would have stayed the slip mentioned in Mr. Livesey's report; but before proceeding further let us examine the cause of this slip. I have already shown that this ground diminished in bulk at the edge of the excavation at the rate of 15·75 per cent., and that this quantity decreased as the square of the distance. We have seen also from the strata that it is mostly of a peaty nature, and deficient in alumina, which is so characteristic

in clay. Then, for argument, we will take the block of buildings at the corner of Francis Street, which are joined together as one mass, and rest upon some 4 feet of slag, which, in its turn, is, as it were, floating on the ground described; the surface water being gradually drained by the excavation. In the meantime the ground above keeps its position, for the weight of the nearest building is supported by the next one to it, and in this manner the buildings are being gradually undermined by the loss of the sustaining power of the water, and this continues to go on until the weight of the projecting building equals the resistance of its materials, the consequence being that the weight then comes suddenly upon the sometime undermined ground, and compresses it almost to its original density, which compression will be exactly the same as the bulk or volume of water hat has been taken away from it. I have no doubt that if no buildings had been near, the ground would have given way from its own weight at some later period. Therefore this slip is due to the drainage of the surface water.

To sum up, the failure was caused by the continual loss of the sustaining power of the water under the buildings, and thus reducing the gravity of the ground until the projecting buildings were strained beyond the adhesiveness of their materials, and consequently parted. The whole weight of the dislocated buildings (about 900 tons) falling suddenly for a depth of five-eighths of an inch upon the now lighter ground, caused it to give way, and by so doing put about 800 tons of earth into motion, making a total of 1700 tons; therefore the actual pressure against the wall would be $= F \sin. \theta$. This angle is found by taking the distance from the parted brickwork and the bottom of the peat, which gives an angle of 20°; we have then $F \sin. \theta = 1700 \times \cdot342 = 581$ tons as the pressure exerted on the ring of concrete walling. This being of an insufficient strength to resist such an unexpected pressure, it broke, and was subsequently carried forward until the angle of repose of the ground was reached. Therefore the failure was caused by the drainage of the surface water.

We will now consider the proposed plans for avoiding a failure in future. It is quite evident that neither Mr. Cail nor Mr. Livesey anticipates any difficulty from the surface water, for neither gentleman has provided for this emergency in his plans. I, nevertheless, still hold to my opinion, and I have no hesitation in stating that I believe, when the excavation has been cleared from water for a short time, the buildings will settle still more. No doubt a system of strong piling will assist their stability and prevent slip.

With regard to the scheme of building a smaller tank in the interior of the present one, I cannot see that it shows any engineering tact, although, no doubt, a smaller diameter with the same thickness of wall would be stronger; but that would be sacrificing the capacity of the tank for the purpose of utilizing a broken wall, which is of no use whatever, for, being completely broken at that side near the buildings, it offers them no protection, while at the opposite side, no buildings being near, the wall is quite sound, which simply shows that in building the new wall no assistance will be required from the old one.

Again, both gentlemen suggest that the new tank should be increased in depth, which is a decided improvement. The depth of tanks having been duly considered, both by the members of the Institution of Civil Engineers and the members of the British Association of Gas Managers, it was found that a depth of less than one-fifth of the diameter was not desirable; for gasholders less than one-fifth are liable to get out of level, and consequently stick, and thus cause great annoyance.

With regard to carrying the tank above the ground level, I consider the plan to be bad, and should only be resorted to in cases where it is expensive or difficult to sink the foundations; for instance, such as hard rock. Tank walls above ground are difficult to keep tight, and are more exposed to the wind.

With reference to the supporting power, Mr. Livesey's plan depends at once upon the area of the base of the wall, for the backs being made up with artificial ground no supporting power from the sides will ensue. Now it is well known to engineers that vegetable clay cannot be relied upon for heavy foundations without assistance, which is obtained by piling down to a firmer stratum, or by the supporting power gained from the frictional resistance of the surface of a number of piles. With reference to Mr. Cail's plan, he appears to be under the impression that a partial upheaval took place in the tank. If so, the line of inclination would be below the bottom of the foundation, and at an angle of 35°. To meet such circumstances Mr. Cail's scheme cannot well be surpassed, but I find from inquiries that no upheaval took place, and such being the case, the line of inclination must be somewhat above the bottom of the foundation. I have already taken this line at 20° in a previous calculation, and my reason for doing so will be quite apparent on examining the nature of the ground, for in all probability it would give at an acute angle from the surface to the peat, and then run along the peat until it reached within a short distance from the edge, from which point it would again run in an acute angle towards the bottom of the foundation. The resistance to lateral strain would therefore be best served by a strong footing and strengthening uprights at intervals.

It must also be borne in mind that, in sinking a foundation to a greater depth, the additional weight of the material as well as the stratum must be considered. Taking one of the cylinders mentioned in Mr. Cail's report as an example, in the first place we find that the bottom of the cylinder is in the same stratum, therefore the supporting power at its base must be the same. Thus it is evident that the only power gained will be that derived from the frictional resistance of its sides, which will be for the ground in question ·2 of a ton per square foot.

We have then for the brickwork round the cylinder—

$$\frac{(7\cdot5^2 \times \cdot7854) - (6^2 \times \cdot7854) \times 14}{27} \times 1\cdot35 \quad . \quad . \quad . \quad . \quad . \quad . \quad = \text{Tons. } 11\cdot133$$

and for the concrete in its interior we have—

$$\frac{6^2 \times \cdot7854 \times 14}{27} \times 3\cdot37 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad = 49\cdot406$$

Giving a total of non-supporting power in tons . . . = 60·539

and for the frictional resistance we have—

$$7\cdot5 \times 3\cdot1416 \times 14 \times \cdot2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad = 65\cdot973$$

Giving a gain of supporting power for each column . = 5·434

or $\frac{5\cdot434}{329\cdot8} = \cdot0164$ of a ton per square foot.

Assuming, therefore, that a firmer stratum cannot practically be reached, the supporting power would be better served by timber piles, for, in driving piles, the whole of the material driven through is compressed on all sides, whereas, in sinking cylinders, the material is excavated from their interiors. Besides, timber piles have a great tendency to adhere, or grow, as it were, to the earth, and are also much lighter in themselves. From these considerations, I think we may safely assume that the surface friction of piles will be one-fourth greater than cylinders, and taking a cubic foot of Memel to weigh 34 lbs., we have for frictional resistance—

$1 \times 4 \times \cdot25 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad = 1\cdot0000$

Then *minus* the weight of pile per foot run . . . . = ·0151

Total per cubic foot . . . . . ·9849

or $\frac{\cdot9849}{4} = \cdot2462$ of a ton per square foot. Showing a gain of supporting power in favour of timber piles of (·2462 : 2298 :: 100) = 93·3 per cent.

I now wish to call your attention to a plan that I have designed, which will be found to have the following advantages:—1. Of overcoming all obstacles. 2. Of avoiding pumping, so that the safety of the adjacent buildings is secure. 3. Of being more permanent and durable, the weight on base per square foot being nearly one-half less than the other schemes proposed. 4. Of being as cheap as the other schemes, capacity compared. 5. Of being of the original diameter, so that no extra cost will be incurred by the alteration in the diameter of the holder. And, lastly, but not least, the reputation of Middlesbrough engineering would not be at stake by submitting to such an ordinary difficulty.

The proposed tank is rectangular in shape, constructed of cast-iron plates, bolted together with bolts an inch in diameter, all joints being made with iron cement. There are 10 tiers of plates on the outer circle, and seven on the inner circle, each tier having 114 plates in its circumference. The outer and inner bottom tiers are 1½ inch thick and 18 inches in depth. These tiers form the shoe, the next outer and inner tiers are 1¼ inch in thickness, the circumferential flanges of which are 12 inches wide, the bottom one being for the purpose of resting on the bearing beams attached to the piles; and the top one being for the purpose of bolting the tier and bottom plates thereto, so that the bottom plates can be removed independently when required. The width of these flanges is designed for resisting lateral pressure. The bottom plates are in two lengths across a width of 11 feet, and are 1¼ inch thick, the remaining outer and inner tiers are 1 inch and three-quarter inch respectively. Round the inside of the outer circle are 24 U columns 4 feet 9 inches by 4 feet 9 inches and 1 inch thick, which are placed at equal distances apart, each U being cast in two parts, and corresponding to the tier plates in depth, and are bolted thereto and together by 1 inch bolts, the flanges of which are left off at the corners at an angle of 45°, so as to span the circumferential tier flanges. The vertical centre flanges form at once girders for fixing the guide-bars thereto, and on the tops are bolted sole-plates 5 feet 9 inches by 5 feet 9 inches and 1¼ inch thick, for the purpose of receiving the columns. The U columns before mentioned also form the strengthening uprights for resisting lateral pressure. At the first joint from the top of the inner circle a flange is provided on its inner side, to which is bolted a ring of woodwork 9 inches by 3 inches, and on the top of this again is built a brick and cement wall 2 feet 6 inches in depth, thus by these means securing a tight joint. The interior of the tank is excavated to the bottom of the peat, after which a layer of tempered clay 4 feet in depth is laid on the top, and then a layer of concrete 15 inches thick; upon this again is bedded a top covering of a brick on edge in cement. The brickwork is strengthened at the corner in such a manner that any settlement in the interior will not affect the joint or crack the covering. The inlet and outlet pipes are in the tank, the bottom plates for two widths being dished, so that the pipes lie clear of the bottom of the holder. The tank is 193 feet 6 inches and 171 feet 6 inches in diameter respectively, and 36 feet in depth clear, and can be erected upon the top of the present wall, the outer and inner circle overlapping each side of the wall, the bottom division, forming the air chamber, being completed, and having fitted on the top two air locks, two water shafts, and two supply-pipes. Underneath the bottom flange, and resting on the wall at intervals are bearing beams, which will regulate the lowering of the structure, the next tier being added as the work progresses. Fixed to each U column are three temporary brackets for the purpose of keeping the tank in a proper form. When the tank has been sunk to a sufficient depth, so as to be clear of surface water, which can be proved by reducing the air pressure occasionally, one width of bottom plates at each side of each U column can be taken off, and the excavation completed in the usual way. The piles can then be driven, after which the whole air chamber can be filled with concrete, thus forming at once a ring of the section of 11 feet by 7 feet 9 inches, which is sufficient to resist any lateral strain that may come against it. The holes in the bottom plates for air-locks, &c., can then be covered with blank flanges.

With reference to the comparative weights on base of foundations, I have assumed that Mr. Livesey's wall is as shown on drawing; the dimensions I have gathered principally from his report. The weights are calculated as follows:—

Mr. Livesey's.

	Tons.
Brickwork lining	1204
Concrete	7075
Water	1768
20 columns	313
Wheels	20
Brackets and guide-bars	17
Girders	9
Balance-weights	50
Roof girders	30
Holder	190
Giving a total of	10,676

Then we have for weight on base $175^2 \times \cdot7854 - 155^2 \times \cdot7854 = 5183$ square feet. Then $\frac{10,676}{5183} = 2\cdot059$ tons per square foot.

Mr. Chatto's.

	Tons.
Ironwork	1364
Concrete	5709
Water	6343
24 columns	375
Wheels	24
Brackets and guide-bars	21
Girders	10
Balance weight	57
Roof girder	36
Holder	240
Bolts	44
Giving a total of	14,223

Then we have for supporting power from side—

$193\cdot5 \times 3\cdot1416 \times 26 \times \cdot2 = 3161$
$171\cdot5 \times 3\cdot1416 \times 26 \times \cdot2 = 2801$ . . . . . = 7832

And for 1920 cubic feet of piles we have $1920 \times 4 \times \cdot25$ = 1920

Giving a total weight on base in tons of . . . 6341

Then we have for weight on base $193{\cdot}5^2 \times {\cdot}7854 - 171{\cdot}5^2 \times {\cdot}7854 = 6306$ tons, or $\frac{6341}{6306} = 1{\cdot}005$ tons per square foot; or again, in favour of my plans $(2{\cdot}059 : 1{\cdot}054 :: 100) = 46{\cdot}4$ per cent.

In the above calculation, it will be observed that I have only taken the depth of sides for the supporting power from the bottom of the peat downwards, for from that point upwards the nature of the ground is such that the frictional resistance will be reduced to a minimum. Also, with respect to walls, the backs being made up with artificial ground, no supporting power from the sides will ensue.

We will now compare the costs for each plan.

The following are the quantities and prices in detail for my plan:—

1364 tons of tank plates, at £4 12s. 6d. per ton	£6308	0	0
43 tons of 1-inch bolts, nuts, and washers for tank plates, at £20 per ton	860	0	0
5½ cwt. of 1¼-inch bolts, nuts, and washers, for column sole plates, at 20s. per cwt.	5	4	6
1¼ cwt. of ¾-inch bolts, nuts, and washers, for fastening timber to top flange for building brickwork upon, at 20s. per cwt.	1	5	0
1½ cwt. of 1¼-inch bolts and nuts, for bolting bearing beams to plates, at 18s. per cwt.	1	2	4
4 cwt. of ½-inch plate washers for ditto, at 8s. per cwt.	1	12	0
¾ cwt. of bolts, nuts, and washers, for blank flanges, for sand-pipe holes, at 21s. per cwt.		15	9
2400 holes drilled at machine, 1 inch by 1 inch, suitable for the 1-inch taps	12	0	0
2400 holes, taped one inch by hand, at 2½d. per hole	25	0	0
1377·5 tons, at 8d. per ton, carriage dues (delivered)	45	18	0
3532 plates, erected, bolted, and stemmed complete	318	3	0
8045 cubic yards of old wall and ground excavated, at 1s. 7d. per cubic yard	636	18	0
2316 cubic feet of piling and bearing beams complete, at 3s. per cubic foot	347	8	0
1724 cubic yards of concrete, formed by crushing the old work and remixing it with one-seventh part Portland cement, at 6s. per cubic yard	517	4	0
3850 cubic yards of tempered clay from Linthorpe, and worked complete, at 2s. per cubic yard	385	0	0
855 cubic yards of cement concrete for tank bottom, at 6s. per cubic yard	256	10	0
45 cubic yards of brickwork round internal diameter of tank, laid in one part Portland cement and one part sand, at 18s. per cubic yard	40	10	0
2566 superficial yards of brick on edge paving, in one part Portland cement and one part sand, at 4s. per superficial yard	513	4	0
537 feet by 9 inch by 3 inch timber curbing round internal diameter of tank, to build upon, fixed complete	9	0	0
135 bushels of iron cement, at 1s. 6d. per bushel	10	2	0
Total	£10,295	5	7
Add 5 per cent. for profit	514	15	4
Contractor's extra plant—			
5½ tons of temporary brackets, at £4 12s. 6d. per ton — £25 8 6			
3½ tons of water shafts, at £15 per ton — 52 10 0			
2 air-lock doors and connections — 15 0 0			
2 supply-pipe doors and connections — 15 0 0			
Total — £107 18 6 at 25 p. c.	26	9	7
Final total	£10,836	10	6

And which gives according to capacity—

Chatto's—

$188^2 \times {\cdot}7854 \times 36 = 946{,}881$ c. ft., and $\frac{£10{,}836\ 10s.\ 6d.}{946{,}881} = 2{\cdot}7452$d. per c. ft.

Cail's—

$150^2 \times {\cdot}7854 \times 32 = 565{,}488$ cub. ft., and $\frac{£6900}{565{,}488} = 2{\cdot}7934$d. per cub. ft.

Livesey's—

$165^2 \times 7854 \times 30 = 641{,}475$ cub. ft., and $\frac{£7000}{641{,}475} = 2{\cdot}6188$d. per cub. ft.

Johnson's contract—

$\frac{£6945}{641{,}475} = 2{\cdot}5986$d. per cubic foot.

With reference to the air pressure required, I think 9 lbs. will not be exceeded. With regard to the health of the workmen under air pressure, it has been found that if the hours of labour are decreased in proportion to the pressure—that is, if a man can work 10 hours without detriment in an ordinary atmosphere of 15 lbs., he can work with the same result for 7½ hours in 1½ atmosphere, the time being divided into two portions as usual. Working in compressed air is not at all disagreeable, but may be said to act as a pleasant stimulant, causing that feeling which gives an inclination to laugh, although to remain too long at one time is ultimately exhausting.

In conclusion, I may state that I am indebted to the kindness of Mr. Dunning and Mr. Booth, for the reports of Messrs. Cail and Livesey, and also for the particulars of the strata.

PROPOSED EXTENSIONS AT THE INVERNESS GAS-WORKS.

It was mentioned in our issue for the 4th of December that the Police Commissioners of Inverness had requested Mr. Alexander Smith, manager of the Corporation Gas-Works, Aberdeen, to examine and report upon the state of the gas-works which have now been placed under their control, and the improvements which he would recommend to be made upon them. That gentleman has executed his commission, and his report shows that he has gone into the subject with great care and considerable detail. The following is a summary of it:—

Taken as a whole, Mr. Smith considers the plant to be in good working order. He finds that rich coal is used which not only gives between 1000 and 2000 cubic feet of gas more than coal of second quality, but also gives light of superior quality, a plan which he recommends, especially on account of the fact that the carriage is as much as 11s. per ton. The retorts are smaller than those commonly used in modern gas-works, but he is afraid that larger retorts could not be got into the ovens. He commends the plan of reducing the duration of the charges from six to four hours, which the present manager has adopted, and which economizes the carbonizing of the coal and improves the quality of the gas, and he urges that a further reduction to three hours should be made.

As regards the storeage power of the gasholders he is very decided in his opinion. Compared with the consumption in the depth of winter it is very small, the aggregate capacity of the two holders being only 60,000 cubic feet, whereas the greatest daily consumption is about 130,000 cubic feet; thus showing a deficiency of 70,000 cubic feet of holder power, which is a very disagreeable position to be in, as the gas cannot be made either satisfactorily or economically when the storeage power is so much under the consumption. Great forcing is required at one period of the night in order to prevent the gasholders from grounding and the lights of the town going out, while during a portion of the day the retorts are lying idle for want of room to store the gas. There is thus severe tear and wear, and fuel and wages must be expended whether gas be made or not.

To meet these difficulties, Mr. Smith recommends the erection of a gasholder of 100,000 cubic feet capacity, thereby increasing the storeage capacity to about 160,000 feet, or about 30,000 feet in excess of the largest daily consumption at present. The proposed gasholder would be 80 feet in diameter by 20 feet deep, and constructed so that it might be telescoped at any future time, when larger storeage may be required. After indicating ground that should be acquired for the site of the proposed gasholder, and for the future extensions of the retort-house, stores, &c., Mr. Smith goes on to speak of the gas-mains, showing how very small mains are disadvantageous, and recommending that a district governor be got for the purpose of reducing the pressure in the higher levels of the town. He urges the desirability of having all the small and defective pipes replaced by larger ones, so as to reduce the very large per centage of unaccounted-for gas. The bulk of the service-pipes are only half an inch in diameter, a size which should not be laid, he says, under any circumstances. He observed that the public lamp fittings were very defective, and, on inquiry, he found that the work was not done under the superintendence of the gas manager, and he recommends that both it and the lighting should be under his charge.

On the question of meters he also makes some recommendations. The meters in use amongst the consumers are mostly of the wet kind, which he considers the best. But a great number of them are not stamped in accordance with the Sales of Gas Act, and he strongly advises that they be altered to meet the requirements of that Act, as they would then be a reliable measure between buyer and seller. He would have a number altered yearly, until the whole were gone over, and he recommends that wet meters should be taken out and tested at least once in every ten years, and dry meters once every three years.

In Mr. Smith's opinion it is in these things that the defects of the Inverness gas undertaking lie—namely, in main and service pipes, public lamps, and customers meters; and it is only by close attention to these, he says, that the unaccounted-for gas, amounting to 29·94 per cent., can be reduced to any satisfactory extent; for, if the plant were in good order, the leakage, or unaccounted-for gas, should not exceed from 10 to 15 per cent.

After referring to the illuminating power of the gas, which he tested on two successive days, and found to be equal to at least 29 standard candles, or 9 candles above the requirements of the local Act, and equal to the highest quality supplied to any town, Mr. Smith proceeds to speak of the question of price:—"The present price of gas is 7s. 6d. per 1000 cubic feet. Many consumers appear to think that the price of gas should be the same in all towns. This idea, however, is quite erroneous. The difference in the carriage of coal, the quality of the gas supplied, the amount of capital employed, the quantity of gas sold per mile of main-pipe, and the nature and extent of the area supplied, must all be taken into account when drawing a comparison. After my inspection, I came to the conclusion that if the same judicious management be continued that I saw, a reduction in the price of gas will soon follow; but it is impossible to make gas of the same quality you are now supplying at a cheap rate, because rich cannel is always getting scarcer and advancing in price."

He concludes his interesting and valuable report by briefly indicating the extensions that he would propose to be taken in hand, and their cost. They are—gasholder, tank, and connections, of the estimated cost of £4800; and mains and connections, £400—or a total of £5200. The time required to complete the work should be about seven months. As it appears to Mr. Smith to be dangerous to delay with the gasholder, he urges that it be gone on with at once.

WATER GAS IN AMERICA.

Reports on the Lowe Process of Gas Manufacture.

The *American Gaslight Journal* publishes two reports on this subject which we reprint. The first is a report addressed by Professors Rogers and Stephens to the Board of Trustees of the Philadelphia Gas Company, who have had the Lowe process in operation at their Manayunk Station; the second is in the form of a letter by Professor Morton of Stevens Institute of Technology, New Jersey, of his examination of samples of Lowe gas as manufactured at Harrisburgh. A detailed account of the Lowe process and of the apparatus employed was given in this Journal, vol. xxvii., pp. 93, 94.

Philadelphia, May 11, 1877.

To the Trustees of the Philadelphia Gas-Works.

Gentlemen,—In accordance with a request made by chief engineer Mr. T. R. Brown, that we should examine the Lowe process for the manufacture of illuminating gas, as conducted in the works constructed by that company on the premises of the Manayunk Gas-Works, test its illuminating power, and determine its chemical composition and its quality to resist low degrees of temperature, and report upon the same; and also upon any points of incidental importance that might present themselves during the investigation, with a view to the availability of said gas for city lighting purposes, either when used alone, or when mixed with the ordinary city gas, as at present manufactured from coal, we beg leave to submit the following report.

The investigation which was submitted to us began Dec. 27, 1876, and in its several directions has been pursued, with many interruptions, owing to engrossing professional engagements, up to a recent date.

A great number of experiments have been made of a preliminary and comparative kind, having reference to methods of gas analyses, &c. It has been thought by us best to omit reference to such, and to confine this communication, for the most part, to a report upon the facts bearing directly upon the question with the gas trust, as to the availability of the Lowe gas as a substitute, in part or entirely, for the ordinary illuminating gas from coal.

The photometrical testing of the Lowe gas, as manufactured in their works at Manayunk, was conducted under four different modes of collecting it.

In the first instance, it was examined in the photometric-room of the works, being drawn directly from the large gasholder on the premises, and passed through the small meter to the standard burner.

In the second instance, owing to the large gasholder having been made the recipient of both the ordinary gas and the Lowe gas, and it not being the object to examine a mixture of such, it was collected in two large

india-rubber bags, of five cubic feet each, from the outlet of the meter of the Lowe works, and conveyed to the laboratory of Professor Rogers at the University of Pennsylvania, and from these bags transferred to a gasometer over water.

In the third instance, it was collected in two india-rubber bags, similar to those just mentioned, by tapping the pipe leading from the purifiers to the large meter. These were taken to the establishment of Mr. W. W. Goodwin, and there the gas was transferred to a gasometer and experimented on.

In the fourth instance, a large tin gasholder, of 20 cubic feet capacity, was sent to the works at Manayunk. It was there filled with water, and connected with the tube which was tapped into the pipe between the purifiers and meter of the works; the water was then allowed to flow out and the gas to flow in. The opening of this holder was then soldered tight, and the vessel conveyed to Mr. Goodwin's establishment.

For experimenting on the gas, portions were successively transferred to a small gasometer.

The production of gas from each charge varies between 4000 and 6000 cubic feet, and each operation at "running," during which the gas is made, lasts 30 minutes. Dividing off the 30 minutes into periods of five minutes each, it is found that the quantity of gas produced is far greater during the earlier periods than the later ones; and that, on the other hand, the gas which comes over during the later intervals, is much richer in illuminating materials than that which comes over during the earlier stages.

It, was, therefore, a nice problem to so adjust the collection, either in the bags or the larger vessel sent to the Manayunk works, as to secure a mixture that would represent accurately the average of its quality. However, it is believed that, with the precautions taken, no serious error has arisen from that source.

Yield of Gas as observed by the Meter, for Periods of Five Minutes each, up to the Close of the Run, which, in every case, was of 30 Minutes Duration.

First Run.

First five minutes	1600	cubic feet.
Second "	1200	"
Third "	800	"
Fourth "	600	"
Fifth "	550	"
Sixth "	450	"
Total yield	5200	"

Second Run.

First five minutes	1100	cubic feet.
Second "	1600	"
Third "	1050	"
Fourth "	750	"
Fifth "	650	"
Sixth "	450	"
Total yield	5600	"

Consumption of anthracite coal, first run	248 lbs.
Consumption of crude petroleum, "	16 gals.
Consumption of crude petroleum, second run	17 gals.

The following are the results of photometric examinations of the Lowe gas, as taken by the different modes above alluded to:—

Examination at Manayunk.

Gas drawn directly from gasholder, average of five one-minute observations . . . . . 12·51 candles.

To obtain 16-candle light it was necessary to burn 7¼ cubic feet.

Examination at Laboratory of Dr. R. E. Rogers.

Gas taken from Manayunk works, through large meter and transferred to small gasometer from bags, average of ten one-minute observations, normal temperature . . . . 13·95 candles.

Average of five observations, through coil, at 0° . . . . 12·16 "

Pressure . . . . . ·85 inch.

Examination at the Establishment of W. W. Goodwin Esq.

Gas taken from pipe tapped between the purifiers and the large meter, and transferred to small gasometer from bags at Mr. Goodwin's, average of ten one-minute observations . . . . . 14·45 candles.

Candle burning 120 grains, 15-hole Argand burner, 7 inch chimney.

Pressure . . . . . ·85 inch.

Examination at Establishment of W. W. Goodwin, Esq., on the day after preceding Experiments.

Gas in large vessel filled from pipe tapped between purifiers and large meter at Manayunk Lowe gas-works, average of twenty-one one-minute observations . . . . . 15·00 candles.

On freezing same at temperature 0°, average of five one-minute observations . . . . . 10·30 "

General average of all the observations . . . . . 13·48 "

With a view to test the effect of burning the Lowe gas with different burners, the following trials were made, with the results appended:—

At the time of the experiment the City gas gave, with a 15-hole Sugg 16-candle burner . . . . . 17·75 candles.

The Lowe gas gave with a

16-candle, or 15-hole burner, an average of	12·00	"
16-candle, or 24-hole burner, an average of	12·5	"
14-candle, or 21-hole burner, an average of	10·5	"
19-candle, or 27-hole burner, an average of	9·00	"
Pressure at meter	·8	inch.

A Sugg bats-wing, burning 5 cubic feet per hour and pressure 1½ inch, equal . . . . . 3·5 candles.

It thus would appear that for the Lowe gas the 16-candle burner is the best.

From the above results, it would appear that the Lowe gas, manufactured at Manayunk, and supplied to us in the manner described, is inferior in illuminating power to that of the City gas as at present made from bituminous coal.

It should, however, be here stated, that since the Lowe gas owes its illuminating value (all other things being equal) to the amount of hydrocarbons derived from crude petroleum, it is in the power of the manufacturer to control, within a wide range, its quality by the use of a larger or smaller quantity of the oil.

The problem, therefore, of the ability of the Lowe gas to compete with, or replace, the ordinary coal gas resolves itself into the question, whether the cost of petroleum may be such as to admit of its being used in such large quantities as to produce a gas so highly charged with hydrocarbons as to possess an illuminating power much beyond that found by us in the present instance.

Wishing to confine ourselves purely to the facts which have come within our observation—we will not undertake to say what may or may not be accomplished by any future experiments or improvements upon the present mode of manipulation or manufacture of the Lowe gas.

Composition of the Lowe Gas.

Without entering upon the question whether this gas is of the variety known as "water gas," modified by a chemical reaction between such and the petroleum vapour, the settlement of which would require an investigation not within the scope of our instruction, we here append the averages of several very carefully constructed analyses, and a comparison of the same with the city gas made from coal.

Analysis of the Manayunk Gas, showing wide Variations in Composition.

Lowe Gas brought from Gasholder at Manayunk.

Hydrogen	42·86
Marsh gas	44·28
Olefiant gas	5·18
Carbonic oxide	3·43
Carbonic acid	·69
Sulphuretted hydrogen	·80
Oxygen	·14
Nitrogen (estimated)	·56
Ammonia, &c.	2·06
Total	100·00

Lowe Gas taken from Pipe tapped between Purifier and Large Meter.

Hydrogen	64·66
Marsh gas	24·73
Olefiant gas	4·81
Carbonic oxide	2·72
Carbonic acid	·19
Sulphuretted hydrogen	·80
Oxygen	·41
Nitrogen (estimated)	1·31
Ammonia, &c. (estimated)	·37
Total	100·00

Analysis of City Gas for Comparison.

Hydrogen	47·72
Marsh gas	38·53
Olefiant gas	5·20
Carbonic oxide	1·90
Carbonic acid	·94
Sulphuretted hydrogen	1·03
Oxygen	·17
Nitrogen (estimated)	·85
Ammonia, &c. (estimated)	3·66
Total	100·00

(Signed) R. E. Rogers.
Lemuel Stephens.

Stevens Institute of Technology, Hoboken, New Jersey, Oct. 31, 1877.

Dear Sir,—The gas of which I now send you the analysis was collected by my assistant, Mr. W. E. Geyer, about ten o'clock in the morning of Oct. 20, at the Lochiel House, in Harrisburgh.

Connection was made from one of the gas-burners, by means of a short piece of rubber hose, to one after another of a number of glass tubes, of an inch in diameter, but drawn down to a very small size at either end.

After the gas had been allowed to flow freely for some minutes, the tubes were sealed by drawing out in the flame of a lamp, first at the outer end, and then next to the supply.

After these tubes had been filled, a quantity of the gas was allowed to bubble through a solution of acetate of lead, producing a considerable precipitate of lead sulphide.

Then the gas was allowed to flow through a glass tube immersed in a freezing mixture of ice and salt.

In this tube there was collected a considerable amount of volatile liquid, which proved, on examination, to be essentially benzine.

The tubes of gas, and the other materials, were then brought to my laboratory, in this place, where duplicate analyses were made of the gas, with the following results:—

	First. Analysis.	Second. Analysis.	Average. Analysis.
Carbonic acid	4·27	3·83	4·05
Olefines	13·89	14·34	14·12
Carbonic oxide	27·40	26·25	26·82
Marsh gas	22·54	23·70	23·12
Hydrogen	30·64	31·31	30·97
Nitrogen	1·09	·49	·79
	99·83	99·92	99·87

Regarding the determination of the carbonic oxide as of special importance, I then made a third determination, in which, after removing the carbonic acid and olefines as before, I determined the carbonic oxide by absorbing it with chloride of copper, in place of exploding it as in the more usual method; this method gave for the per centage of carbonic oxide 26·54, which is evidently a very satisfactory agreement with the other determinations.

Looking at the character of this gas, as shown by its composition, we are struck, in the first place, by the very large proportion of carbonic oxide which is present, and which is a very objectionable constituent, as it is one of the most virulent and dangerous of gas poisons, and as a consequence renders the accidental escape or leakage of such a gas liable to become the cause of fatal results.

All the standard writers on chemistry agree in stating that the presence of even a few per cent. of this gas in the air of a room renders it utterly unfit for breathing, and often even fatal.

It is even stated, on good authority, that the use of gas containing carbonic oxide has been interdicted by the Parisian Government as injurious to health, and that a commission, composed of the most prominent French chemists, reported to the same effect. (See the London Journal of Gas Lighting, Feb. 19 and June 10, 1856.)

Again, even when the gas is burned, and the carbonic oxide converted into the less dangerous carbonic acid, we still have a serious difficulty, for this gas also is of an objectionable character, and any addition to the amount produced by ordinary gas is to be deprecated; but the above analysis shows that this Harrisburgh gas will yield, in burning, about 70 per cent. more carbonic acid that an ordinary coal gas, and will, therefore, tend to vitiate the air of the rooms in which it is burned 70 per cent. more than the same amount of ordinary coal gas.

Though the amount of sulphuretted hydrogen, in the gas examined, was not determined, being only a small fraction of a per cent., yet the very marked properties of that gas render even this small amount very manifest, and liable to cause serious inconvenience.

A piece of paper containing acetate of lead, and perfectly dry, held over a jet of this gas was instantly blackened, and its ill effects on lead paint or

paper containing, or coated with, white lead can, therefore, be easily surmised.

After combustion, the sulphur of this sulphuretted hydrogen would finally reach the condition of sulphurous and sulphuric acids, whose destructive and corrosive effects are familiar to all.

In reply to your question whether a "water gas" can be made which shall not contain an excessive amount of carbonic oxide, I reply that no practicable method is known. By working with very hin fires, nearly all the oxygen of the water might be converted into carbonic acid; but, unless this was removed by an immense expenditure of lime in purifiers, it would render the gas useless for illuminating purposes, and, if removed, the yield of gas would be very small, and its production very expensive.

(Signed) HENRY MORTON.

The *Polytechnic Review* publishes the following criticism upon the report of Professors R. E. Rogers and Lemuel Stevens to the Trustees of the Philadelphia Gas-Works upon the Lowe process at Manayunk, by Mr. G. S. Dwight, of Springfield, Mass.:—

The investigation of new methods for the generation of illuminating gases not only opens a wide and attractive field for the expert, full as it is of subtle questions in chemical analysis, but the subject is one of great popular interest. Our American communities have, within the last few years, reached the conviction that the cost of gaslight is unreasonably high, and now occupy a position of antagonism toward the companies, such as led some time ago in England and continental Europe, to stringent governmental interference between manufacturer and consumer. Hence the trial of the Lowe process upon an increased scale of practical operations, at Philadelphia, was watched with much interest, because its uniform success, on an ascending scale, at various other places has given promise of usefulness.

It was therefore with regret, not to say surprise, that after long delays it was rumoured that the experts of the Gas Trust had reported adversely upon it. As a very spirited controversy is at present in progress in that city between the City Council, the Gas Trustees, and the Press, as to the fairness of the trial accorded to the new system, a discussion to which many other communities are listening, a presentation of some facts connected with the examination by Dr. Rogers and Professor Stevens, and an analysis of their report may be opportune.

It should be stated that the works at Manayunk were erected without any cost to the Philadelphia Gas Company, by private parties, upon the following terms:—

The contractor was to have control of the holder used for that district, and was privileged to make 200,000 cubic feet per day, at a specified price, provided so large a quantity was required for local distribution. On a fulfilment of the contract the cost of the works was to be paid by the trust, which was thereafter to have licence for use of the process on payment of a stipulated royalty. These facts are mentioned as interesting evidence, that the onus of the trial lay on the contractor. It was provided that the gas delivered into the holder should possess standard illuminating power—viz., 16 candles; that it should not exceed ·600 density, and its cost in holder should be within a prescribed price, and that it should be no more liable to condensation than coal gas.

These four points were left to the determinrtion of Dr. R. E. Rogers, of Pennsylvania University, and Professor Lemuel Stevens, of Girard College, who upon the 11th of May last rendered this report. It is published in connection with this paper, and reference thereto is asked in the review which it is designed to make herein of the circumstances attending the investigation and the methods employed.

The circumstances at the time of the examination were peculiarly unfavourable, and rendered it almost impossible to obtain accurate or trustworthy results.

The new method which, up to this period, had been making the entire supply for that district, was suddenly restricted to a small proportion, the remainder being derived from the coal benches. The gas in the holder was, in consequence, a mixed one, which it was not desired to study, and the experts were therefore compelled to depend for their investigation upon samples, drawn back of the holder, at the meter inlet. This expedient is an exceedingly doubtful one in any gas system, but is precarious in the extreme in the Lowe process, which, in an increased degree, depends on the law of diffusion in the holder for an equalization of the gases, which in their generation are inconstant, both in volume and quality. For this disadvantage the examiners were, of course, in no way responsible. They admit it embarrassed their labours; but they express the belief "that, with the precautions taken, no serious error has arisen from that source." From this belief, however, the writer most respectfully but emphatically dissents, and not on theoretic grounds merely, but because the results and deductions of these gentlemen vary so widely from those reported by other experts, equally eminent, whose investigations at Manayunk and elsewhere were conducted under more favourable circumstances as to point to this fact as a source of error. If the Philadelphia trustees were sincerely desirous of settling strictly upon its merits a question of great public importance, a period somewhat earlier or later might have been selected for its determination, when the process was operating independently, and this grave disadvantage would thus have been avoided.

Another objection is raised against the treatment of the samples thus obtained. The taking of illuminating gas for test by water displacement, and in rubber bags, is not now practised where accuracy is demanded, because of more or less action on the sensitive hydrocarbons, &c. Nor is the conveyance in mid-winter over long distances, repeated transfers by means of water, and a suspension over the same for weeks, calculated to improve the luminosity of gas. Regarding the tests themselves, as reported by Messrs. Rogers and Stevens, exception is taken to the manner in which they were many of them made, and especially to the form in which they are presented in the report, since by reason principally of the omission of data, it is not possible for their professional brethren to check their calculations and determine their correctness; hence the exact value of the examination is left undecided.

The question of condensability, which is of great importance, since upon the permanency of a gas depends the ability of the manufacturer to give the distant consumer a satisfactory quality of light, besides saving the cost which loss in transit necessarily involves, is not commented upon. This is the stranger, since very interesting tests were made with remarkable results, as follows:—A coil of 50 feet of half-inch lead pipe was packed in a cask of ice, snow, and salt, until a temperature of zero was obtained, into which the Lowe gas was admitted and held for 60 minutes. Photometric observations, before and after this test, showed a loss of illuminating value of less than one-half of a candle, and no deposit in the coil. For comparison, the city gas made from coal was similarly exposed, and ceased to burn in three minutes, leaving considerable residuum in the pipe.

The density of the gas is another matter, not only of practical moment, but so indispensable in a determination of other questions under investigation, and for a verification of analysis, that the silence of the report on this point creates surprise.

The illuminating power of the Lowe gas seems to have been selected as the determining point of the whole investigation, and since its alleged insufficiency constitutes the sole and only objection raised against it by Messrs. Rogers and Stevens (and this is an objection never before raised), it will be pertinent to review with special care their treatment of this part of the examination. On the occasion of their first visit to Manayunk, it appears that the holder was in the control of the Lowe process, and at est is mentioned as having been made on the spot, which gave the value at 12·51 candles only. This is the only test free from the objections heretofore mentioned, but the report does not state in what kind of a burner the gas was used, and the entire experiment involved only five one-minute observations, so that its value is very questionable. It should here be remarked that as the principle of the determination of illuminating values is based upon the relative light given out by the consumption of 120 grains of spermaceti in comparison with 5 cubic feet of gas during the same time, usually one hour, so it is extremely unsatisfactory to rely upon a few one-minute tests, because, while the consumption of the gas is constant, that of the candle is variable, showing a difference frequently of several points in as many minutes. Moreover, the density of a gas is in this connection entitled to consideration in the adaptation of the burner to its peculiarity in this respect. Certainly no just comparison lies between the illuminating power of the coal and Lowe gases, in the manner proposed by the experts of the gas trust. They assert that, "at the time of the experiment, the city gas gave with a 15-hole Sugg 16-candle burner, 17·75 candles;" and then give the average aggregate result of 56 one-minute tests, variety of burner not stated, at 13·48 candles, and in this average is included ten observations at zero. In other words, these gentlemen would have one single test of Philadelphia gas, under the most favourable circumstances, decisive as against the average of a number of observations of the Lowe gas, many of which were made under peculiarly unfavourable conditions. It would have been an easy step to still further reduce the average value of the latter by introducing a test with the Bunsen burner. In enumerating trials of different burners, they report that a 19-candle 27-hole burner gave only 9 candles, and yet this identical burner yields to other reputable experts at Manayunk 19·81, and at Lancaster 20·30, for the Lowe gas. Such glaring discrepancies as these justify the inquiry whether, in the investigation of Messrs. Rogers and Stevens, any copper instruments or coils were used. The absorbing power of this metal on the luminous hydrocarbons is so well understood now, that it would not be employed when accurate determinations were desired.

On the basis of these observations, open, as has been seen, to very serious objections, the experts conclude "that the Lowe gas, manufactured at Manayunk, and supplied to us *in the manner described* (the italics are used by the writer), is inferior in illuminating power to that of the city gas as at present made from bituminous coal."

Then follows an acknowledgment which is a full concession of the whole matter—viz., "It should, however, be stated here that since the Lowe gas owes its illuminating value, all things being equal, to the amount of hydrocarbons it contains, derived from crude petroleum, *it is in the power of the manufacturer to control, within a wide range, its quality*, by the use of a larger or smaller quantity of the oil." (Italics as before.) This admission virtually concedes the point at issue, the illuminating power having been the only ground of their objection to the system.

The question raised relative to the supply of petroleum has been pretty well settled by events later than the report; but it may be interesting to state that coal-oil, which can be put into the market at a competing price with petroleum, is at least equally desirable for enrichment, and presents a safe alternative to the manufacturer.

Composition.—The analyses as the averages of repeated tests are, if correct, very interesting, and especially so as developing a feature entirely novel in the manufacture of gases into which water products enter. Reference is made to the unexpectedly small per centage of carbonic oxide shown in the tables. So large a disappearance of oxygen is phenomenal, and opens some very interesting chemical questions not pertinent here. It is to be regretted again that the density of the gas analyzed is not given, that the accuracy of the figures presented might be tested by computation. But, for the purposes of this review, the analyses are valuable to this extent—that they confirm the doubt already cast upon the photometrical observations. A comparison of the composition of the "Lowe gas taken from the pipe tapped between the purifiers and the large meter," and which was the gas tested for candle power, with that of the city gas, leads to the conclusion that the former would burn with a higher illuminating value than the latter. Its per centage of olefiant gas is very nearly identical, with a strong probability of a larger proportion therein of acetylene, one of the most luminous hydrocarbons, while the marked increase of hydrogen in the Lowe gas should secure higher flame temperature, and a consequent increase of luminosity. In addition to this, the large decrease below the Philadelphia gas of those impurities which are known to reduce the candle power of gases is quite noticeable. The presence of the proportion of nitrogen and oxygen mentioned, it is believed, might be charged to the entrance of atmospheric air into the sample during the transfer.

Cost.—On this very practical point the experts express no opinion, but merely give, without comment, the quantities of coal and oil used, during the time of their investigation.

These, however, confirm the claim heretofore made, that 50 lbs. of anthracite and three gallons of crude petroleum are sufficient for the production of 1000 cubic feet of illuminating gas, and strengthens the opinion that the Lowe process is capable, by its reduced cost of production, of competing with the manufacture of coal gas.

In conclusion, it is impossible to escape the conviction that for the purposes of determining so important a public matter as the possible supply of a good quality of illuminating gas, at a reduced price to the consumer, the report of Messrs. Rogers and Stevens is not competent, and this conclusion is reached solely by an analysis of the report itself, independent of examinations by other professional gentlemen, which may be presented hereafter.

GEO. S. DWIGHT.

AMALGAMATION OF THE MELBOURNE GAS COMPANIES.

In the JOURNAL of the 13th of November last we gave an abstract, from the *Melbourne Argus*, of the scheme for the amalgamation of the City of Melbourne Gas and Coke Company, the South Melbourne Gas Company, and the Collingwood, Fitzroy, and District Gas and Coke Company. The amalgamation was to take effect from the present day, contingent upon the Companies obtaining an Act of Parliament sanctioning the same. That Act has been obtained, and consequently the several undertakings are now merged in one, under the title of "The Metropolitan Gas Company."

We learn from a recent number of the *Melbourne Argus* that the Bill promoted by the Companies underwent several changes during its passage through the Legislature. The Bill, as originally presented, provided for the payment of maximum dividends of 12½ per cent., for the offer of new shares to existing shareholders at par, and for the creation of a large reserve-fund. The standard of illuminating power was 14 candles, and

maximum price of gas 7s. 6d. per 1000 cubic feet. There was no provision for inspection of accounts.

As amended in the Select Committee of the Assembly, a sliding scale of price and dividend has been incorporated in the Act. Taking the standard price of gas at 7s. 6d. for the first five years and 7s. afterwards, and taking the initial dividend at £10 per cent., it is provided that the Company shall not pay any higher rate without reducing the price of gas in a given ratio, and that all surplus profits shall be divided in equal proportions between the shareholders and the consumers of gas. New shares are to be put up to public auction or tender, no dividend being payable upon the premiums received thereby. Lastly, an official auditor is to be appointed, with power not only to test the accuracy of the accounts of the Company, but to see that all the items are properly charged to capital or to revenue, as the case may be. The reserve-fund has also been limited in amount, and the standard of illuminating power has been raised from 14 to 15 candles.

Power is given by the Act "to any Metropolitan Board of Works which may hereafter be constituted, to purchase the undertaking and property of the United Company," and the terms of purchase are to be based upon a calculation of eighteen years profits of the Company. The Select Committee inserted a clause in the Bill limiting the sphere of the Company's operations to a radius of eight miles of the Post Office, instead of granting the twenty miles radius asked for by the promoters. There is no provision for the periodical publication of accounts.

IRON AND COAL TRADES OF SHEFFIELD, SOUTH YORKSHIRE, AND NORTH DERBYSHIRE.

(FROM OUR OWN CORRESPONDENT.)

During the week just ended the amount of business transacted has been practically nothing, seeing that all the large iron and steel works have been entirely closed, and most of them still remain so. The interval is, as usual, being utilized for stock-taking, and for effecting necessary repairs to or alterations of machinery and plant. At several large concerns new engines are being put down for rolling-mill and general purposes, and at the Bessemer establishments there is a general movement for much more powerful machinery, and the adoption of still greater economy in the production. The other leading markets of the country having also been closed or purely inanimate, it will not be necessary to do more than mention the fact that all brands of pig iron have been absolutely neglected, and altogether nominal in price all round. The same is the case in respect of finished and merchant iron.

The collieries have for the most part been closed all the Christmas week, but at a few of the larger pits a re-start was made on Thursday morning, the existing demand for house coal being now strong, owing to the seasonably severe weather. At the same time the market is much within the capacities of the means of supply. Coke is neglected.

THE LANCASHIRE COAL AND IRON TRADES.

(FROM OUR OWN CORRESPONDENT.)

There is no material change to notice in the condition of trade since last week, the holidays still, to a large extent, interfering with business. Many of the pits and iron works were closed during a great part of last week, and in the majority of cases there will be nothing doing during the whole of the present week.

The better classes of round coal for house fire purposes are still almost the only description of fuel that meet with anything like a good inquiry, and the present severe weather will no doubt stir up the demand for this class of coal, which has been unusually dull for the time of the year. Other classes of fuel continue a drug, and the holidays at the mills and iron-works have temporarily put a stop to the local demand for forge coal and engine fuel. There is a good deal of pushing for orders amongst merchants and dealers, and for sales in bulk prices are very irregular, but with the exception of a slightly weaker tone in common coal for steam purposes, the current market quotations are without change. Best screened Wigan Arley, for house fire purposes, is quoted at the pit mouth at 10s. to 11s. per ton; common ditto, 8s. to 9s.; Pemberton four-feet, 8s. to 8s. 6d.; common Wigan mines, for house fire purposes, 6s. 6d. to 7s.; common coal for steam and forge purposes, 5s. 6d. to 6s. 6d.; burgy, 4s. 6d. to 5s. 6d.; and ordinary slack, 2s. 6d. to 4s. per ton, according to quality.

The shipping trade is still extremely dull, and those collieries that are mainly dependent upon this class of business to clear off their supplies are very badly off for orders, while there is so much competition in the market that exceedingly low prices have to be taken.

There has been little or nothing doing in the iron trade during the past week, and prices nominally are without change; the quotations for delivery into the Manchester district ranging about as under:—Lancashire pig iron, No. 3 foundry, 51s.; No. 4 forge, 50s. per ton, less 2½ per cent.; Derbyshire, No. 3 foundry, 50s. 6d.; No. 4 forge, 49s. 6d., less 2½; Middlesbrough, No. 3 foundry, 48s. 9d.; No. 4 foundry, 47s. 9d.; No. 4 forge, 47s. 3d., net cash. Lancashire and Middlesbrough bars, £6 5s. to £6 7s. 6d.; Staffordshire, £6 7s. 6d. to £6 10s. per ton.

The Lancashire finished iron makers, owing to the low prices now ruling in the market, have determined to make a reduction of 5 per cent. in wages, and, considering the present depressed state of trade, no serious opposition on the part of the men is expected.

THE COAL AND GENERAL TRADE OF THE NORTH OF ENGLAND.

(FROM OUR OWN CORRESPONDENT.)

Last week, being Christmas, there was a large amount of broken time at the Durham collieries, and, of course, a lessened production for the time. The pits, however, are working as steadily as they usually do at this season of the year, and are getting a fair share of trade. There are not many reports of extensive contracts having been made yet in gas coals for next year; and, from the uncertainty which surrounds everything connected with the coal trade, and in view of a slight tendency to lower rates, it is not probable that the Gas Companies will enter upon large transactions in advance, except at very moderate rates. The present official quotation is about 8s. best, and 7s. for medium qualities of gas coals; but for immediate business many collieries seem to take a lower quotation than this for cargoes. Second-class gas are about 6s. 6d. No doubt, after the holidays are closed, the gas coal trade will open out very steadily, and the pits will work up to full time. There is every probability that the lock-out of miners in the Northumberland steam coal trade will continue over January, at least, and that the tendency of it will be to improve the value of second-class Durham coals. Winter having set in suddenly in the North, the price of house coals tends upwards a little.

The coasting trade is particularly dull this Christmas. Whatever little business is put into the market is snapped up greedily even at the low quotations current. Severe frost is reported from the Baltic, which will stop all shipments thence. The last coasting quotations were as follows:—London, steamer, 4s. 3d.; Dublin, 6s. 6d.; Havre, 6s.; Rouen, 7s.—all for gas coals. Sailing ships are getting about 6s. 3d. per ton to discharge gas coals at the wharves below bridge. No great amount of steam coal is being shipped from the Tyne. There is every appearance that freights will greatly favour shippers over the month of January.

There was little work astir last week in the factories or building yards, holiday being very general. Trade prospects are not very cheering at present, and there is much destitution amongst the working classes, and an absolute dearth of fuel at the dwellings of many of the Northumberland miners. The chemical market is very dull.

TRADE NOTES FROM SCOTLAND.

(FROM OUR OWN CORRESPONDENT.)

The movement to which I referred last week as being in progress at North Berwick for the acquisition of the gas supply undertaking by the Town Council has suddenly and unexpectedly collapsed. It was formally resolved by the Town Council that the Burghs (Scotland) Gas Supply Act should be adopted. An opposition, however, arose amongst the ratepayers, and the question of adopting the Act was eventually put to the test of a plebiscite of the householders, with the result of a majority declaring in favour of the action taken by the Municipal Authorities. But within the past few days the Town Council have resolved to abandon the measure in the meantime, in consequence of the keen opposition which was given to it by a large section of the ratepayers. One of my correspondents says that the opposition is much to be regretted, as in his opinion, as also in that of the most respectable portion of the community, the adoption of the Act would have been a great benefit to the town.

Opposition has likewise arisen against the adoption of the Gas Act at Elgin. A remonstrance, signed by upwards of forty of the ratepayers, was presented to the Town Clerk a few days ago, in which it was submitted the existing and eventual circumstances connected with the transfer of the gas-works are such that it would be in no way favourable to the ratepayers or consumers of gas generally. Provost Culbard, by advertisement, at once invited those persons who signed the remonstrance to meet with him for the purpose of having a conference on the reasons which had induced them to take action on the subject. No report of the proceedings at the conference has yet come to hand, but it is not improbable that a poll will now be taken to decide the question.

There is room to fear that some confusion and difficulty will arise in connection with the proposal to adopt the Anstruther Gas Act in Airdrie, inasmuch as there is now being floated a new undertaking, designated the Airdrie Gas Consumers Company, Limited, whose "object is to supply gas to its members at the cheapest possible rate." It is also proposed by the new Company "to purchase the works of the Airdrie Gaslight Company, if the same can be got at a fair valuation." It is intended to raise a capital of £20,000, in shares of £1 each, only consumers being shareholders, no member being entitled to more than 50 shares, and each being entitled to five shares. Furthermore, it is stated that only 7 per cent. on the paid-up capital will be paid to the members, the balance of profit (if any) being employed in lowering the price of gas. A very curious clause crops up in the prospectus; it is as follows: "The object of the new Company is not to compete with the Airdrie Gaslight Company; but solely to put an end to the monopoly of supply of gas which they have too long held, and to transfer to the town the right of supplying themselves with the best gas at the lowest possible rate." The promoters of the new Company propose to transfer the profit to the town; but it would almost seem as if they desired the transference to be done at two stages, so that they might do a profitable stroke of business in the final one. However, as a simple chronicler of events, I must not allow myself to give free vent to my suspicions, but shall wait to see how the new movement meets with the approbation of the ratepayers, who are the ultimate court of appeal in such a matter.

In the beginning of December I mentioned that the Burghs (Scotland) Gas Supply Act had been adopted by the Town Council of Peterhead, and I now learn from that town that the time for lodging objections expired on Wednesday last, and that up to the time at which my correspondent wrote none had been lodged. The probability is, therefore, that the Town Council will resolve, at their first meeting, to negotiate with the Gas Company to take over their works and the gas supply undertaking generally.

During the last four weeks large numbers of new gas-lamps have been erected at Burntisland, and at Wellshothill, which is a sort of outlier of the village or burgh of Cambuslang, but in which street lighting has now for the first time been adopted.

Great dissatisfaction has for some time been expressed at the nature of the gas supply of Ballater, an important village near Balmoral; and it is said that while all the persons who have ever used gas there are unwilling to give it up, there can be no surprise if the treatment which they have lately received should cause a general adoption of oil-lamps.

The most important matter in connection with water supply undertakings during the last few days, was the formal inauguration of the Inverness Water-Works. The supply of water is from Loch Ashie, fully six miles distant from the town. The loch yields 70 gallons per head of population per day, or a million gallons daily. The entire scheme cost £81,000.

A very dull condition of things has prevailed in the Glasgow pig iron market during the past week, and prices have fallen lower and lower, business being done last Friday down to 51s. 6d. per ton cash, and 51s. 8½d. one month.

The coal market has not developed any new features during the past week. The demand for shipping sorts is exceptionally quiet for this time of the year, and at present no indications of improvement are experienced. In house coal a rather better business has been done, in anticipation of the New Year's holidays. All other kinds continue in poor demand, yet prices remain quotably unchanged.

WIGAN CORPORATION GAS-WORKS.—At a special meeting of the Wigan Town Council, on the 28th ult., it was resolved, on the recommendation of the Gas Visiting Committee, that the salary of Mr. Hawkins, the Gas Manager, should be increased from £300 to £400 per annum, as and from to-day.

DRAINAGE AND WATER SUPPLY OF HAILSHAM.—The Local Government Board have granted permission, on the inquiry of Mr. Harrison, C.E., to the Municipal Authorities of Hailsham to borrow £6000, for the purpose of constructing a system of drainage through the town—£4000 for proper drainage, and £2000 for pipes to be laid from Polegate to the Eastbourne Water-Works, and from Polegate to Hailsham, on the plan set out by Mr. G. A. Wallis, Engineer to the Board.

SALES OF PROVINCIAL GAS AND WATER COMPANIES SHARES.—On the 21st ult., twelve £25 shares in the Leicester Water-Works were sold at Nottingham by auction at £40 5s. a share, and one share at £39 7s. 6d. At the same sale, Nottingham Water-Works £50 early shares realized £79 and £80 7s. 6d.; £19 5s. ditto, £28 7s. 6d., £28 10s., £29 5s., and £29 7s. 6d.; Derby Water Shares, £12 10s. paid, £21 and £22 12s. 6d.; and Nottingham Corporation Gas Annuities made £78, £78 2s. 6d., £78 5s., £78 7s. 6d. On the 24th ult., 270 new shares in the Dover Gaslight Company were sold by auction, realizing an average premium of 53½ per cent. The maximum parliamentary dividend on these shares is 7½ per cent.

Share List of Metropolitan Gas and Water Companies.

(Corrected by Mr. F. N. Golding, Sun Court, Cornhill, from the latest Stock Exchange Quotations.)

Number of Shares issued.	Amount per Share.	Name.	Amount paid up per Share.	Last Divd. p.Cent. p. Ann.	Latest Quotations.	Number of Shares issued.	Amount per Share.	Name.	Amount paid up per Share.	Last Divd. p.Cent. p. Ann.	Latest Quotations.	Number of Shares issued.	Amount per Share.	Name.	Amount paid up per Share.	Last Divd. p.Cent. p. Ann.	Latest Quotations.
	£	Gas Companies.	£ s. d	£ s. d	£		£	Gas Companies.	£ s. d	£ s. d	£		£	Gas Companies.	£ s. d	£ s. d	£
10000	20	Anglo-Romano . .	20 0 0	0 0 0	20–24	56000	50	*Imprl. Continental*	45 15 0	9 10 0	90–92	1500	10	*Wandsw. & Putney*	10 0 0	10 0 0	19–20
5000	20	Bahia (Limited). .	20 0 0	3 0 0	9–10	9000	5	Limerick Gas . . .	5 0 0	2 10 0	3–3½	1500	10	Do.	10 0 0	7 10 0	11–12
1000	20	Do., do., redeem.	20 0 0	10 0 0	..	383000*l.*	Stk.	*London*	100 0 0	10 0 0	185–188	2957	10	Do.	10 0 0	7 0 0	..
1500	20	Do., 2nd pref. . .	20 0 0	7 10 0	..	1500000*l.*	Stk.	Do., 1st pref. . .	100 0 0	6 0 0	130–135	993	10	Do.	3 0 0	7 0 0	..
40000	5	Bombay (Limited).	5 0 0	7 10 0	7–7¼xd.	14450	Stk.	Do., 2nd pref. . .	100 0 0	6 0 0	120–130	26000	5	*West Ham*	5 0 0	10 0 0	8–9
10000	5	Do., fourth issue.	4 0 0	7 0 0	5–5⅛	4350	Stk.	Do., 3rd pref. . .	100 0 0	6 0 0	120–130						
14000	20	British (Limited) .	20 0 0	10 0 0	38–40	7622	25	Do., A shares . .	25 0 0	6 0 0	32–34						
7500	20	Cagliari (Limited).	20 0 0	5 0 0	15⅛–16⅛	268051.	All	Do., Debent. stk.	100 0 0	5*l.* & 6*l.*	..						
5500001.	Stk.	*Commercial*	100 0 0	10 0 0	185–188	15000	5	Malta and Mediterranean (Limited).	5 0 0	2 0 0	2–2⅛						
70000	100	Do., 7 per cent. .	..	..	138–142												
20000	20	Continental Union.	20 0 0	6 0 0	19–20	6000	5	Do., preference .	5 0 0	7 10 0	5–5⅛						
20000	20	Do., new	12 10 0	6 0 0	½ds-par	20000	5	Mauritius (Limited)	2 5 0	..	¼–1						
10000	20	Do., preference .	20 0 0	7 0 0	24–26	25000	20	Monte Video (Lim.)	20 0 0	8 0 0	16½–17½			Water Companies.			
75000	Stk.	*Crystal Palace District*	100 0 0	10 0 0	195–200	8000	10	Nictheroy, Brazil (Limited)	10 0 0	5 0 0	..	100					
125000	Stk.	Do., 7 per cent. .	100 0 0	7 0 0	138–142	30000	5	Oriental (Calcutta).	5 0 0	9 10 0	7¼–7¾	12000	100	Chelsea	100 0 0	6 0 0	150-4xd.
50000	Stk.	Do., preference .	100 0 0	6 0 0	125–135	30000	5	Do., new shares .	3 0 0	9 10 0	1¼–2pm.	1800000	50	East London . . .	100 0 0	6 0 0	151-3xd.
23406	10	European(Limited)	10 0 0	10 0 0	17–18	10000	5	Ottoman (Limited).	5 0 0	3 0 0	2–3	8000	25	Grand Junction . .	50 0 0	5 0 0	81-83xd.
12000	10	Do., new shares.	7 10 0	10 0 0	6–7pm.	10000	10	Parà (Limited) . .	10 0 0	2 0 0	4½–5½	5840	25	Do., ½ shares . .	25 0 0	5 0 0	40–41
35406	10	Do., new shares .	5 0 0	10 0 0	3¼–4½pm	27000	20	*Phœniz*	20 0 0	10 0 0	37–39	2160		Do, new ditto; max. div.,7½ p.c.	25 0 0	5 0 0	33–34
4094840*l.*	Stk.	*Gaslight & Coke* A.	100 0 0	10 0 0	185–188	3600000*l.*	100	Do., new max. 7½	60 0 0	7 10 0	105–110		100				
1000000*l.*	Stk.	Do. B.	100 0 0	4 0 0	80–85	1440000*l.*	Stk.	Do., capitalized .	100 0 0	5 0 0	100–105	547960	100	Kent	100 0 0	8 0 0	200–205
50000	10	Do. 5 per ct. pref. conv., 4th issue.	10 0 0	5 0 0	6½–7¼pm	37500	20	Do., new, 1876. .	..	..	14–15pm	970	100	Lambeth	100 0 0	6 5 0	151–155
50000	10	Do. do., 5th do. .	4 0 0	5 0 0	5½–6¼pm	7359	5	Rio de Janeiro (L.)	20 0 0	10 0 0	28–30	1161	100	Do., max.,7½ p.c.	100 0 0	6 5 0	148–152
2000000*l.*	Stk.	Do. C 10 p.c. pref.	100 0 0	10 0 0	200–210	2000	5	Singapore(Limited)	5 0 0	7 10 0	5¼–5⅞	442	100	New River	100 0 0	7 0 0	320–350
3000000*l.*	,,	Do. D do. do. .	100 0 0	10 0 0	200–210	1500	32½	Shanghai	32 10 0	12 0 0	30–32	4475	100	Do.	85 0 0	7 0 0	280–300
1650001.	,,	Do. E do. do. .	100 0 0	10 0 0	200–210	4000	50	*South Metropolitan*	50 0 0	11 0 0	108–111	400000	100	Do., deb. sk.,4 p.c.	100 0 0	4 0 0	103–105
300001.	,,	Do. F 5 do. do. .	100 0 0	5 0 0	103–107	4000	12½	Do.	12 10 0	10 0 0	25–27	3036	100	Southwrk. & Vauxh.	100 0 0	4 0 0	98-103xd
600001.	,,	Do. G 7½ do. do. .	100 0 0	7 10 0	145–155	20000	12½	Do., new shares .	10 10 0	10 0 0	13–14	1296	100	Do., pref. stock .	100 0 0	5 0 0	113–116
1300000*l.*	,,	Do. H	100 0 0	7 0 0	136–139						pm.	..		Do., D shares . .	100 0 0	4 0 0	96–101
6200	5	Georgetown,Guiana	5 0 0	5 0 0	..	15000	10	*Surrey Consumers.*	10 0 0	10 0 0	17¼–18½	..	100	Do., new ord. No.1	40 0 0	4 10 0	..
5000	10	Hong Kong (Lim.)	10 0 0	10 0 0	18–20	10000	10	Do., new	8 0 0	10 0 0	6–7pm.	1600	100	Do., new ord. No.1	40 0 0	4 10 0	..
												12172	61	West Middlesex . .	61 0 0	6*l.* p.sh.	138–141

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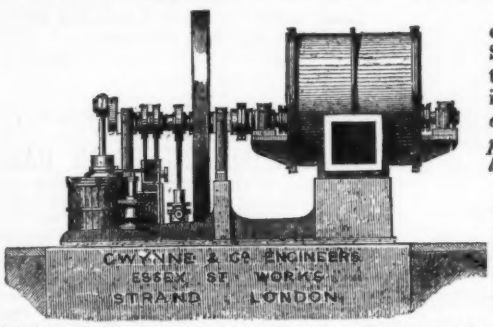

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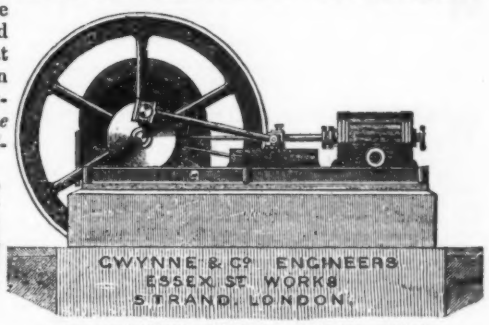

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A 6-in. Governor.
A Station-Meter, to pass 20 cubic feet per revolution.
A quantity of Connexions.
Apply to THOS. SMITH, Gas-Works, Cannock, STAFFS.

TO GASHOLDER BUILDERS.

THE Gas Committee of the Borough of Southport are prepared to receive TENDERS for the supply of a Telescopic GASHOLDER, in two 30-ft. lifts, about 150 ft. in diameter.
Drawings and specification of GEORGE ANDERSON, 35A, Great George Street, Westminster, LONDON.
NOTE.—Six Sheets of Drawings and Specification, price Two Guineas, by post.

TENDERS FOR SULPHATE OF AMMONIA.

THE Directors of the Cork Gas Consumers Company are prepared to receive TENDERS for all the SULPHATE of AMMONIA to be manufactured at their works during the year 1878. Delivery f.o.b. Cork. Probable quantity 100 tons. Payment net cash on delivery.
Prices to be fixed on basis of 24 per cent. Ammonia, and tenders to state whether packages are to be supplied free by sellers.
Tenders will be received up to Friday, Jan. 11, 1878.
By order,
DENNY LANE, Secretary.
Company's Offices, 72, South Mall,
Cork, Dec. 13, 1877.

TENDERS FOR SULPHATE OF AMMONIA AND TAR.

THE Directors of the Devonport Gas and Coke Company are prepared to receive TENDERS for their make of SULPHATE of AMMONIA and their surplus TAR for a period of Six or Twelve months, from the 1st of February, 1878.
Estimated make of Sulphate about 90 tons per annum. Tar about 50,000 gallons.
Specifications may be had on application to the Secretary.
Tenders to be delivered on or before Monday, the 14th day of January, 1878, addressed to the Chairman, Devonport Gas and Coke Company.
By order,
JOHN WILLING, Secretary.

TO GASHOLDER MAKERS, &c.

THE Directors of the Northampton Gas Company are prepared to receive TENDERS for a Telescopic GASHOLDER, 100 feet diameter by 30 feet deep.
Plans and specifications may be seen at the Offices of the Company on and after Monday, Dec. 31, and copies of the specification and particulars may be obtained on payment of One guinea.
Tenders, addressed to the Chairman, endorsed "Tender for Gasholder," to be delivered at the Office of the Company on or before Wednesday, Jan. 24.
The Directors do not bind themselves to accept the lowest or any tender.
JOHN EUNSON, jun., Engineer.
Northampton, Dec. 21, 1877.

GAS-WORKS FOR SALE.

THE Proprietors are prepared to receive OFFERS for the Wymeswold (Leicestershire) Gas-Works. The Works consist of Retort-House, with a bench of two and a setting of one retort, Coal-Store, a comfortable Foreman's House, Meter-House, and Store-Shed, together with Retort-Fittings, Condenser, Scrubber, Two Purifiers, Meter, Governor, and Gasholder to contain about 5000 cubic feet, as well as the whole of the Mains throughout the village.
The streets are lighted up by 26 public lamps. The Works are of recent date, in very good condition, and are well situated.
The gas and meter rental amounts to over £200 per annum, and the consumers are steadily on the increase.
Further particulars to be obtained of Mr. J. B. BALL, Gas Engineer, LOUGHBOROUGH.

TO TAR DISTILLERS AND OTHERS.

THE Directors of the Plymouth and Stonehouse Gaslight and Coke Company are prepared to receive TENDERS for the surplus TAR produced at their Works for One year from the 1st of January next. The Company will deliver the Tar free into vessels through their main at the Creek, Sutton Pool, or into Contractor's carts on the Works. Payments to be made monthly.
Parties desiring to tender can ascertain further particulars on application to the Secretary, at the Company's Offices, 1, Athenæum Terrace, Plymouth, to whom tenders are to be sent on or before Wednesday, the 2nd day of January next.
The Directors give notice that they do not bind themselves to accept the highest or any tender.
By order,
G. HENDERSON, Secretary.
Dated Dec. 20, 1877.

LEEK IMPROVEMENT ACT, 1855.

TO GASHOLDER MAKERS.

THE Leek Improvement Commissioners invite TENDERS, with plans and specifications, for the supply and erection of a TELESCOPIC GASHOLDER, with two lifts of 30 feet each, the outer lift to be 80 feet in diameter.
Tenders to be addressed to the Chairman of the Gas Committee, Leek, and sent in before Four o'clock in the afternoon of Monday, the 7th of January next, endorsed "Tender for Gasholder."
The lowest or any tender will not necessarily be accepted.
Further information may be obtained on application to the Manager at the Gas-Works, or the undersigned.
C. HENSHAW, Clerk.
Commissioners Offices, Leek, Dec. 14, 1877.

CAMBRIDGE GAS-WORKS.

TO BUILDERS AND CONTRACTORS.

THE Directors of the Cambridge University and Town Gaslight Company are prepared to receive TENDERS for the construction of a Retort-House, Coal-Sheds, Purifying-House, Meter-House, Residence, Office, and other works.
Drawings and specifications may be inspected, and forms of tender and schedules of quantities may be obtained (on payment of the sum of Three Guineas, to be returned on receipt of a *bona fide* tender) at the Office of the Company, in Sidney Street, Cambridge, and at the Office of Messrs. Thomas and Charles Hawksley, Civil Engineers, 30, Great George Street, Westminster, S.W., on and after Thursday, the 3rd day of January next, and tenders must be delivered at the Office of the Company on or before Wednesday, the 16th day of January next.
The Company do not pledge themselves to accept the lowest or other tender.
By order,
WILLIAM PEED, Secretary.
Cambridge, Dec. 20, 1877.

REMOVAL.

CHARLES HEISCH, F.C.S., Analytical and Consulting Chemist, Superintending Gas Examiner to the Corporation of London, &c., &c., has REMOVED from 8, Savage Gardens, to 79, MARK LANE, where he may be consulted as usual.

M. BREMOND'S NAPHTHALINE PROCESS.

All negotiations respecting M. Brémond's patented process for preventing Deposits of

NAPHTHALINE

in Gas Main and Service Pipes should be addressed to Mr. W. H. BENNETT, 22, Great George Street, WESTMINSTER, S.W., or to M. BREMOND, Gas Engineer, Gas-Works, VERSAILLES, near Paris, who may be consulted upon all matters connected with the Gas Industry.

GAS and WATER SHARES.—Forty fully paid-up £20 Shares in the Ventnor Gas and Water Company.
Messrs. DEBENHAM, TEWSON, AND FARMER will SELL the above at the Mart, on Tuesday, Jan. 8, at Two o'clock, in Four Lots.
Particulars of the AUCTIONEERS, 80, CHEAPSIDE, E.C.

TO HYDRAULIC, GAS, & HOT-WATER ENGINEERS, FIRE-ENGINE MANUFACTURERS, LOCAL BOARDS, CONTRACTORS, PLUMBERS, AND OTHERS.

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MR. BILLINGAY will Sell by Auction, at Taylor's Depository, near the Elephant and Castle, S.E., on Thursday, Jan. 17th, and following Day, at one o'clock prompt, the above, including Steam and other Cocks, High-pressure Valves, Gauges, Grease Cups, Syphons, Fire and Sluice Cocks, Hose Fittings, Stand Posts, Street Boxes, Hydrants, Road Watering-Posts, Deep Well, Force, and other Pumps, Iron, Gas, and Water Piping, Lavatory, Bath, and Closet Fittings, and a variety of other Goods of a like character.
May be viewed two days prior and on mornings of Sale. Catalogues at place of Sale; of Mr. E. GREATHEAD, Accountant, Moorgate Street Chambers, MOORGATE ST., E.C.; and of Mr. BILLINGAY, Metal Trades Valuer and Auctioneer, 64, King William Street, LONDON BRIDGE, E.C.

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NOTICE.

THE GAS & WATER COMPANIES DIRECTORY, 1878.

(WATER SECTION.)

The Editor will feel greatly obliged if Secretaries and Engineers would fill up, and return to him at once, the forms sent them, as the work is now going to press. If any have not received Forms, they will be forwarded immediately, on application to the Editor,

CHARLES W. HASTINGS,

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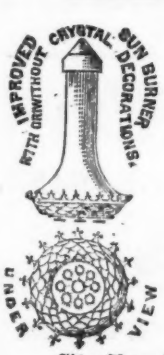

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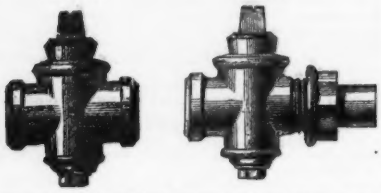

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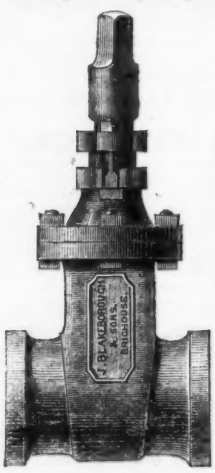

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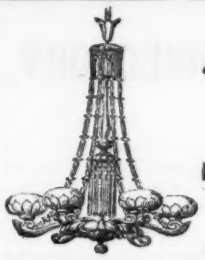

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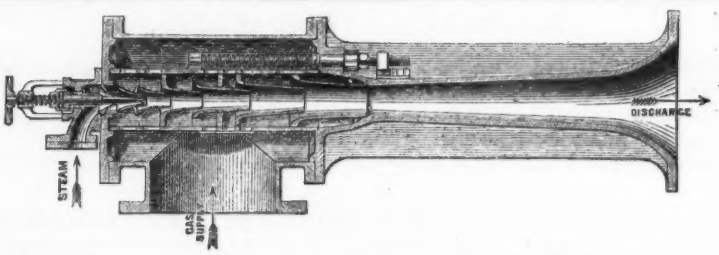

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INVITE THE ATTENTION OF GAS COMPANIES AND OTHERS FOR THE SUPPLY OF

EVERY DESCRIPTION OF GAS APPARATUS.

ENGINEERING DEPARTMENT.

NEW GAS-WORKS erected complete. Plans and Estimates furnished. MAINS, METERS, SERVICES, LAMPS, &c., adapted for Towns of any size. Gas Companies advised on Improvements, Extensions, and Alterations of Works.

GASHOLDERS AND TANKS.

RETORTS and RETORT-HOUSE FITTINGS, CONDENSERS, SCRUBBERS, ENGINES and EXHAUSTERS, PURIFIERS, STATION-METERS, GOVERNORS, VALVES, &c.

METER DEPARTMENT.

They beg special attention to the excellence and superiority of their WET and DRY METERS, several thousand being now in use by many of the largest Gas Companies in the West of England and South Wales. Warranted to measure correctly, and not to vary. Their acknowledged superiority has brought them into general use more rapidly than any Meters hitherto manufactured. A guarantee of Five years tendered with each Meter.

GAS-FITTING DEPARTMENT.

An extensive variety of Choice Designs in CHANDELIERS, PENDANTS, BRACKETS, STAR and SUN LIGHTS, MEDIÆVAL FITTINGS for CHURCHES, &c.

PATTERN-BOOKS and PRICE LISTS furnished.

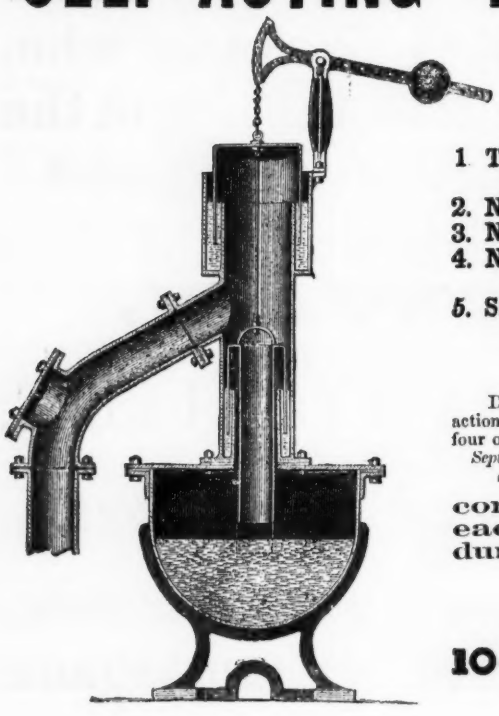
☞ PLEASE NOTE THE ADDRESS—

GAS ENGINEERING WORKS, COMMERCIAL ROAD, EXETER.

SELF-ACTING REMOVABLE DIP-PIPE,

PATENTED BY

CHANDLER & STEVENSON.



ADVANTAGES.

1. There is no pressure on the Retorts.
2. No deposit of Carbon.
3. No scurfing is required.
4. Never a choked Ascension-Pipe.
5. Saves Fuel and Wear and Tear.
6. Gets 10 per cent. more Gas out of the Coal, and a higher Illuminating Power.
7. Is never out of order.
8. Requires no attention.
9. Is perfectly automatic in its action.

Testimonial from the Proprietor of the Apeldorn Gas-Works.

DEAR SIR,—In reply to your inquiry, the Self-Acting Dip-Pipes, which have been in action at my works for two years, give entire satisfaction. I forward you order for four others.

Yours truly,

Sept. 9, 1877. R. BAKKER.

These Dip-Pipes can now be supplied complete, except the flanched bend, for £4 each, which includes the charge for licence during the whole term of the patent.

APPLICATIONS TO BE MADE TO

Messrs. CHANDLER & SONS,

104, NEWINGTON CAUSEWAY, S.E.,

Who fix the Dip-Pipes, at a small Charge, when required.

JOHN ABBOT & CO., LIMITED,

MANUFACTURERS OF

IMPROVED

HYDRAULIC CRANES & HOISTS,

Effecting an IMMENSE SAVING in the cost of discharging Coals from Vessels, Barges, &c.

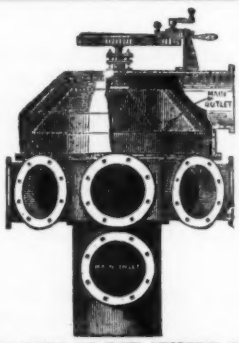
HYDRAULIC RAMS FOR LIFTING AND LOWERING PURIFIER COVERS.

GAS PLANT GENERALLY, PIPES, ROOFING, TANKS, &c.,

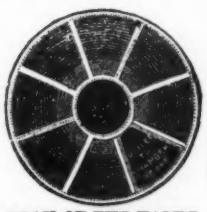
PARK WORKS, GATESHEAD.

LONDON OFFICES: 2, SUFFOLK LANE, CANNON STREET, E.C. | GLASGOW OFFICES: 54, ST. ENOCH'S SQUARE.

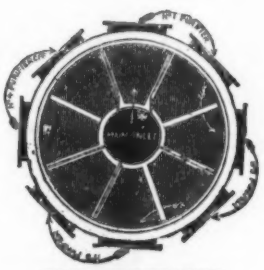
C. & W. WALKERS'
PATENT CENTRE-VALVES.



ELEVATION OF THE CENTRE-VALVE.



PLAN OF THE VALVE.



PLAN OF THE BODY.

These PATENT CENTRE-VALVES are the most perfect and certain means for working Purifiers on the system of three in action, and one out of action. The Valve itself is protected from all injury inside the safety cover. The working of the Valve is so easy, and so governed by the stop-catch movement, that the Purifiers can be instantaneously changed in the dark as well as in daylight. They are scraped perfectly true, metal to metal, the facings heretofore exposed are always covered, and there is nothing more reliable, certain, and durable in a gas-works. By their use the floor of the Purifying-house is clear and level; the Valve and all connexions being beneath the floor, out of the way of working. A considerable improvement and saving is effected in the cost of the connecting-pipes.

MIDLAND IRON-WORKS, DONNINGTON, near NEWPORT, SHROPSHIRE; 8, FINSBURY CIRCUS, LONDON.

THOMAS ALLAN & SONS,

IRONFOUNDERS,

WORKS:

SPRINGBANK FOUNDRY & NORTH WOODSIDE FOUNDRY,

GLASGOW;

BONLEA FOUNDRY, STOCKTON-ON-TEES,

Manufacturers of

CAST-IRON GAS AND WATER PIPES.

SIZES: ¾ to 12 inches at GLASGOW.

„ 1½ to 10 „ STOCKTON.

A LARGE STOCK KEPT, AND PRICES MODERATE.

Freight to London, in the Stream, 10s. per ton from Stockton; 15s. from Glasgow.

AGENTS FOR LONDON AND THE SOUTH OF ENGLAND:

THE THAMES BANK IRON COMPANY, UPPER GROUND STREET, LONDON, S.E.

C. & W. WALKER,
8, FINSBURY CIRCUS,
LONDON, E.C.

MANN & WALKERS' PATENT SCRUBBER.

By Letters Patent in Great Britain, Europe, and the United States of America.

By some important improvements recently patented, the purifying power of these Scrubbers has been much increased, and a stronger ammoniacal solution obtained, which is found to absorb a large portion of the carbonic acid contained in gas, effecting an important saving in money and labour in the lime purifiers, and where oxide only is used, the increase in the illuminating power of the gas obtained by these Scrubbers is shown in a remarkable degree, in consequence of the large quantity of carbonic acid removed from the gas.

It is to be particularly noted that the important results of these Scrubbers do not depend upon the machinery alone. The entire internal construction of the Scrubber bears an almost equally important part. For this reason, where it is desirable to convert existing Scrubbers, whose dimensions happen to be suitable, the work commences by ripping out the whole of the interior of the shell, and beginning the internal construction *de novo* from bottom to top.

Fifty million cubic feet of gas per 24 hours are purified from ammonia by these Patent Scrubbers in a winter's day in the gas-works of London, where the purity of gas supply is the highest in the world, under the chemical restrictions of the Board of Trade.

Generally, wherever a high standard of purification is maintained in the chief cities and towns of the British Provinces and of Europe, these Scrubbers have become established.

By their use the department of purification from ammonia upon a gas-works is made complete, without the aid of prepared oxide of iron, chemicals in purifiers, or any other supplementary process, and the whole ammoniacal residual product contained in the coal is absorbed and obtained in the form most profitable to a gas company, while the requirements of all Acts of Parliament and of the Board of Trade, relating to incorporate gas companies, are satisfied.

Foul Gas, properly condensed, entering the inlet is, by once only passing through the Scrubber, completely purified from ammonia with regular certainty day by day, without any further trouble, or any other process, effected by a very small quantity of clear water let into the machinery room at the top of the Scrubber, which is discharged at the liquor outlet at the bottom, from Newcastle coal at about 18 to 20 ounces strength, from Yorkshire and other coals, generally from 25 to 30 ounces strength; while acidulated litmus or turmeric exposed at the Scrubber outlet will not show the slightest discoloration, and there is not a quarter of a grain of ammonia per 100 feet left unabsorbed.

They contain their own engine power, requiring only a small inappreciable quantity of steam from the gas-works boiler, and are then complete in themselves, ready for service.

Applications relating to dimensions and prices should be addressed to us, C. AND W. WALKER, 8, FINSBURY CIRCUS, LONDON, E.C., or to Mr. WILLIAM MANN, late Superintendent of the Chartered Gas-Works, BLACKFRIARS, LONDON; they should state approximately the largest make of gas in 24 hours on a winter's day, and the smallest make on a summer's day, to be purified.

LESMAHAGOW CANNEL COAL.

FERRAND DAVIES,
148, GRESHAM HOUSE, OLD BROAD STREET, LONDON, E.C.,
SOLE AGENT FOR
THOMAS BARR'S LESMAHAGOW MAIN CANNEL.

Quotation and Analysis forwarded on application.

E. & W. H. HALEY,

General Ironfounders and Makers
OF
CAST-IRON GAS AND WATER PIPES.
Sizes 1¼ to 15 inches.

LISTER HILLS FOUNDRY, BRADFORD, YORKSHIRE.

GAS PURIFICATION.

BAILES & HALLSWORTH,
CONTRACTORS FOR THE
PURIFICATION OF COAL GAS
BY THEIR
PATENT HYDRATED PEROXIDE OF IRON MATERIAL.

The Material is adapted specially for taking up sulphuretted hydrogen, and will simultaneously absorb any ammonia that may pass the scrubbers.

The spent oxide resulting from our Material is more valuable than that from natural oxide of iron, and manufacturing chemists buy it in preference.

The Material has now been in use during the past three years in most of the principal Gas-Works in Yorkshire and elsewhere.

It contains considerably less moisture than natural oxide of iron, and is much cheaper and more efficient as a purifying agent.

B. & H. are purchasers of Spent Oxide, or will take Spent in exchange for New Material.

FOR SAMPLES AND TERMS, ADDRESS—
BAILES & HALLSWORTH, COPPERAS WORKS, ARMLEY, LEEDS.

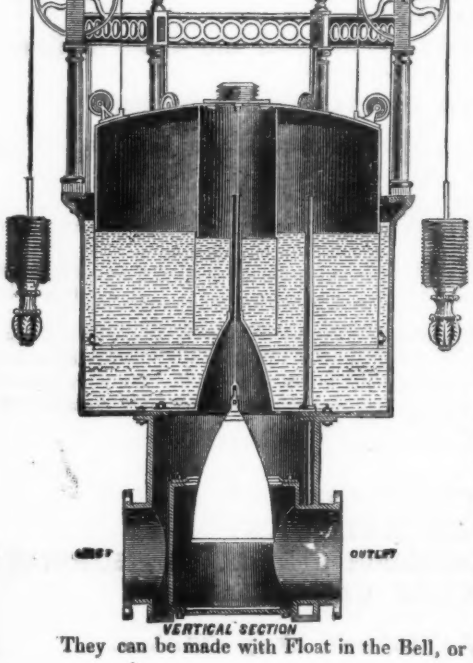
J. & J. BRADDOCK,

GLOBE METER-WORKS,
OLDHAM,

Beg to submit to Gas Engineers their

PATENT COMPENSATING GAS GOVERNOR,

Which is designed to give an uniform pressure at the Outlet to the Main at all draughts up to the full quantities which the Governors are made to control, such outlet pressure being less than the initial pressure.



The uniformity of pressure is obtained by introducing a compensating chamber into the Bell or Holder of the Governor, which compensator is of the same area as the valve, both of which are operated on by the initial pressure, thereby placing the valve in equilibrium, no matter what the initial pressure may be. The action on the Bell is by the Gas passing along a pipe from the outlet, and the pressure is regulated by weights in connexion with the Bell as required.

From the sectional elevation attached hereto, it will be seen that only the Gas required to operate the Bell comes in contact with the water of the tank, which water will remain comparatively sweet and free from odour. That in case of accident to the Bell, no more Gas can escape than would pass up the pipe covering the valve-rod and Bell supply-pipe.

These Governors have been made and sent out of various sizes for from 2 to 24-inch Mains, and give most satisfactory results.

They can be made with Float in the Bell, or counterpoise as per section.

ROBERT MARSHALL,

CANNEL COAL MERCHANT,
173, ST. VINCENT STREET, GLASGOW.

SHOTT'S BOGHEAD.

LOTHIAN'S CANNEL
Yields 12,500 cubic feet of 34-candle gas per ton, and 9 cwts. of excellent coke, containing only 4 per cent. of ash.

MUIRKIRK, No. 1, CANNEL
Yields 12,160 cubic feet of 32·5-candle gas per ton, and 10 cwts. of excellent coke, containing only 5 per cent. of ash.

OLD WEMYSS CANNEL
Yields 13,320 cubic feet of 32·5-candle gas per ton.
Prices and full Analyses on application.

GAS COAL.

POPE & PEARSON, LIMITED, have now the authority of several of the most eminent Gas Engineers of London in stating that their Coal yields *in practical working over* 10,000 *cubic feet of gas, with an illuminating power of* 16 *candles;* or by the standard burners now used by the London Gas Companies, an illuminating power equal to 17⅛ candles.

One ton yields 12½ cwt. of good coke. This Coal can be shipped from Hull, Goole, Liverpool, Morecambe, and Barrow.

For further particulars, apply to POPE AND PEARSON, LIMITED, West Riding and Silkstone Collieries, near LEEDS.

SCOTCH CANNEL COALS.

The Subscriber is prepared to contract for the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

JAMES M'KELVIE,
CANNEL COAL MERCHANT,
HAYMARKET, EDINBURGH.
Established 1840.

WILSON CARTER & PEARSON,

GAS COAL AND CANNEL FACTORS,

Supply to any Railway Station or export Best Wigan Arley Gas Coal and Nuts; best qualities of the Derbyshire, Yorkshire, and North Staffordshire Gas Coals and Nuts; also the best descriptions of Lancashire, Welsh, Scotch, and other Cannel.

Messrs. WILSON CARTER & PEARSON, being contractors to several of the principal Gas Companies in the Midland Counties, have pleasure in being enabled to give them as references.

Chief Offices: Temple Buildings, 50, New Street, Birmingham.

London Offices: 6, Great Winchester St. Buildings, E.C.

HEBBURN MAIN GAS COALS.

T. Stone, Esq., of Weymouth, writes on Nov. 17, 1876: "I have used about 12,000 tons of this Coal, with, I think, the best possible results, although not always under the most favourable circumstances. My Coal account made up to Midsummer last showed a makeage of 10,524 cubic feet per ton of 14¼-candle gas, and not a hundredweight of Cannel used. This statement would, I know, be incredible to many men, and may provoke the remark, 'How much of it is paid for?' For the gratification of such, I have to say that, of the above quantity, 9866 cubic feet per ton of Coal carbonized were brought to charge and duly paid for, with the exception of about 6s. per cent. for bad debts. The coke is of excellent quality. The above facts I hold to be a greater recommendation to your Coal than any words of mine could be."

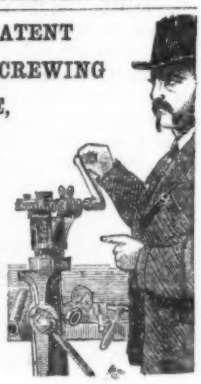
PRICES ON APPLICATION, EITHER F.O.B. OR BY RAIL IN TRUCK LOADS.

THE TYNE COAL COMPANY, LIMITED, OWNERS.
W. RICHARDSON, Fitter,
29, QUAYSIDE, NEWCASTLE-ON-TYNE.

ADDISON POTTER,

WILLINGTON QUAY,
NEAR NEWCASTLE-UPON-TYNE,
Manufacturer of
CLAY RETORTS, FIRE-BRICKS, AND EVERY DESCRIPTION OF FIRE-CLAY GOODS

GRIRDROD'S PATENT
PORTABLE PIPE SCREWING
MACHINE,



For 1 in., 1¼ in., 1½ in., and 2 in. Gas Threads, complete £7 10s.

In use at the chief gas-works, and giving great satisfaction.

For other useful goods, see Bailey's "Illustrated Inventions," post free 3s. 6d.; gratis to ledger customers.

W. H. BAILEY & CO.,
Brassfounders, Gauge Injector and Tool Makers,
ALBION WORKS, SALFORD,
LANCASHIRE.

Established

1795.

JOSEPH CLIFF & SONS,

THE ORIGINAL

WORTLEY FIRE-BRICK WORKS,

NEAR LEEDS,

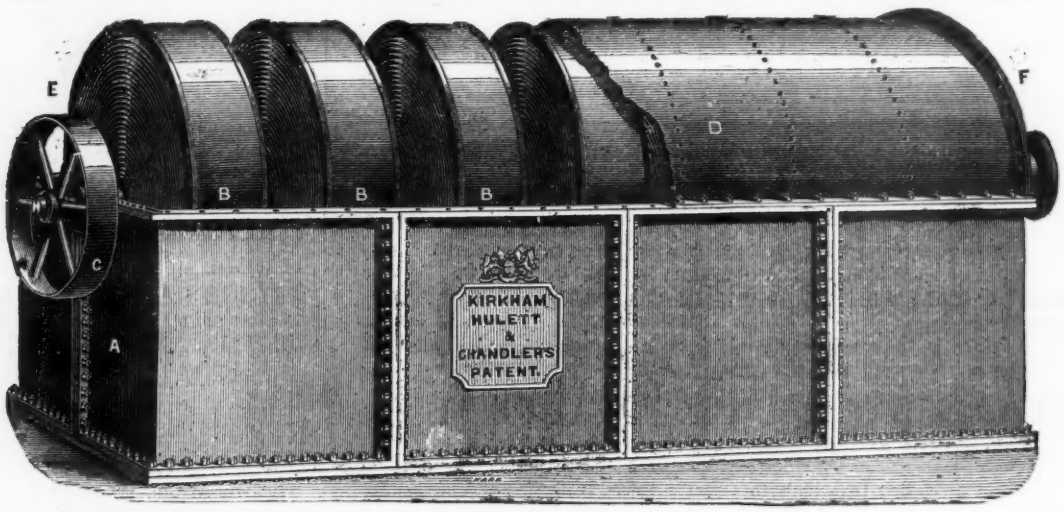
London Wharf: No. 4, inside Great Northern Goods Station, King's Cross, N.;

LIVERPOOL: Back Leeds Street.

SPECIAL NOTICE.—Our Patent Machine-made Retorts have now been in *actual work* nearly 1000 days, and are yet in good order. References on application.

July 2, 1877.

STANDARD WASHER AND SCRUBBER.



The advantages of the Apparatus will doubtless be understood by those interested in gas manufacture.

The principal points of any Apparatus for the extraction of ammonia may be summarily stated as follows:—

1. **A large amount of Surface is desirable.**
2. **Such Surface should be always effectually Wetted.**
3. **The Surfaces or Scrubbing Material should cause no Pressure.**
4. **The Gas should meet various strength Liquors on its course.**
5. **However small the quantity of Water used, it ought to operate over the whole Surface.**
6. **Changing Scrubbing Material is both Objectionable and Expensive.**
7. **Economy both as to Space occupied and Cost of Apparatus is an important item.**

All these requisitions are supplied by the above Apparatus, of which the following is an explanation:—

A is a cast-iron tank, formed into several separate water-tight compartments.

B B B volutes of sheet iron fitted to the centre shaft, which is driven by the pulley, C, and causing the said volutes to revolve each in a separate compartment filled with water or other fluid.

D, the cover, has partitions fitted into it corresponding with those in the tank, sufficient space being left between the top of the partition in the tank and the lower edge of that in the cover, to allow the gas a free passage through the first volute to the second, and so on to the third, fourth, &c.

The action is as follows:—The crude gas entering at E is partly washed in the first compartment, which becomes 10 or 12 oz. liquor, or stronger if required, according to the quantity allowed to enter per ton; the gas then passes to the second, where the liquor is of a less strength; thence into a weaker liquor, as it passes from one compartment to the other, finishing at the last compartment or outlet, F, with clean water, which is constantly flowing and running over from one compartment to another, until it reaches the last space, from which it flows from the outlet-pipe into the well or tank ready for sale or removal.

Taps are inserted in each compartment for the convenience of drawing liquor for testing, &c.

Applications as to Cost, &c., may be obtained of either

Mr. D. HULETT, 55 & 56, HIGH HOLBORN;

Messrs. KIRKHAM & HERSEY, GAS ENGINEERS, 21, ABINGDON STREET, WESTMINSTER;

Or Messrs. CHANDLER, 104, NEWINGTON CAUSEWAY.

Inquirers will please state their Maximum Day Make.

THE SILKSTONE & DODWORTH COAL & IRON COMPANY, LIMITED,

DODWORTH, BARNSLEY.

BENJAMIN WHITWORTH, Esq., M.P. . . . . Chairman.
Mr. RICHARD HARTLEY . . . . . Managing Director.

REAL OLD SILKSTONE GAS COAL.

JAMES PATERSON, Esq., Gas Engineer, of the Warrington Gas Company, reported, Aug. 10, 1875:—

"This Coal possesses remarkable qualities as a gas and coking coal, and appears SECOND TO NONE IN THE KINGDOM. It contains the large quantity of 699 lbs. of illuminating matter, and 1498 lbs. of coke to the ton, and produces **12,240** cubic feet of 16·66 candle gas."

The above Company are raising nearly a thousand tons of the Real Old Silkstone Gas Coal per working day.

PRICES QUOTED TO ANY RAILWAY STATION, OR F.O.B. HULL, GRIMSBY, GOOLE, KEADBY, LIVERPOOL, AND FLEETWOOD.

GAS PURIFICATION & CHEMICAL Co., LIMITED.

(Successors to JOHN WILLIAM O'NEILL & CO.,)

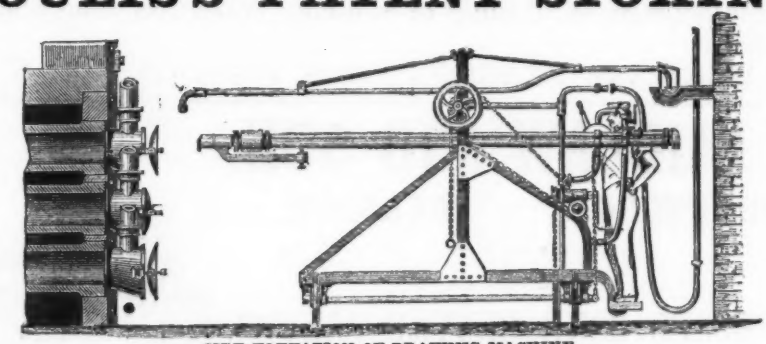
Offices—PALMERSTON BUILDINGS, OLD BROAD STREET, LONDON, E.C.,

CONTRACTORS FOR GAS PURIFICATION BY OXIDE OF IRON.

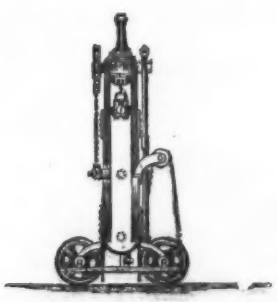
The superiority of the material supplied by this Company is generally recognized, and it is now in use in nearly all the London and most of the large Provincial Gas-Works.

JOHN WILLIAM O'NEILL, SAMUEL H. JOHNSON, } Joint Managing Directors.

FOULIS'S PATENT STOKING MACHINE.



SIDE ELEVATION OF DRAWING MACHINE.



END ELEVATION.

(The Charging Machine will be Illustrated in next week's Advertisement.)

Makers: TANGYE BROTHERS and HOLMAN, London and Birmingham; ADAM WOODWARD and SON, Manchester; ROBERT LAIDLAW and SON, Glasgow; MASCHINENBAU-ACTIEN-GESELLSCHAFT HUMBOLDT, Kalk bei Deutz; Or all particulars may be had from JAMES WOTHERSPOON, 31, St. Vincent Place, Glasgow.

NEWTON, CHAMBERS, & CO.,

THORNCLIFFE IRON-WORKS AND COLLIERIES,

NEAR SHEFFIELD.

CELEBRATED SILKSTONE GAS COALS.

The various descriptions of Gas Coal produced from the above Collieries possess an unequalled reputation, combining in a large degree the constituents essential for the production of the best quality of Coke and Gas of a high illuminating power.

A recent extensive development of the Collieries enables us to offer increased supplies.

JAS. PATERSON, Esq., of Warrington, after testing various qualities of our Coal, has sent the following testimony of their merits:—

"*Warrington Gaslight and Coke Company,*
Offices, Mersey Street, Warrington, April 23, 1877.

"MESSRS. NEWTON, CHAMBERS, AND CO.,

"GENTLEMEN,—After carefully testing the various samples of Gas Coals sent from your Collieries for analysis, I have pleasure in reporting them as belonging to the highest class of Gas and Coking Coals.

"The average of Nine samples gives a yield of **12,500** cubic feet of **15½**-Candle Gas, being equivalent to **664** lbs. of sperm per ton, and **1420** lbs. of fixed carbon of a very superior quality. All the samples bear a close relation to each other in value.

"Yours truly, "JAMES PATERSON."

Full particulars will be sent on application to us—address as above.

CROLL'S
DRY GAS-METERS,

PRIZE MEDALS.
LONDON, 1851;
NEW YORK, 1853
PARIS, 1855.

(INVENTED & PATENTED IN 1844,)

COMBINING ALL THE LATEST IMPROVEMENTS,

MANUFACTURED ONLY BY

PRIZE MEDALS.
LONDON 1862;
DUBLIN, 1865;
PARIS, 1867

THE GAS-METER COMPANY, LIMITED,

238, KINGSLAND ROAD, LONDON, N.E.

TO DIRECTORS OF GAS COMPANIES, GAS ENGINEERS, AND MANAGERS OF GAS-WORKS.

GENTLEMEN,—We beg to remind you that this is the time when all orders of any magnitude for Fire-Clay Gas-Retorts, and all kinds of Fire-Clay Goods likely to be required during next season, should be given out.

In reply to some scandalous reports that have been raised respecting our firm, we take this opportunity of saying that we have been established as the largest makers in the trade for over thirty years; that we are now in a better position than ever to supply our customers; and that, for quality of material, workmanship, and endurance, our goods are equal or superior to any produced. Soliciting your favours, we are, Gentlemen, your obedient Servants,

HARRIS AND PEARSON.

Illustrated Catalogues and Price Lists, or Special Quotation (on receipt of specification), sent free to any part of the World. Also quotations for Cast-Iron Pipes, Wrought-Iron and Lead Tubing. Manufacturers of all kinds of Sanitary Tubes and Blue Staffordshire Bricks of every description.

ADDRESS—HARRIS AND PEARSON, STOURBRIDGE.

R. LAIDLAW AND SON,

EDINBURGH AND GLASGOW,

SOLE MAKERS OF

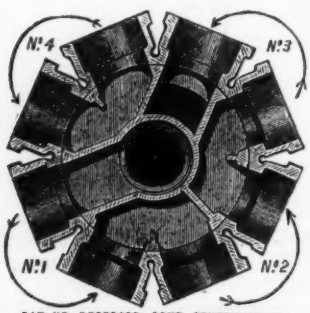
PATENT

RECESSED CONE CENTRE-VALVES,

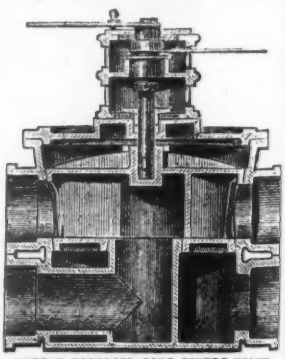
Constructed on the principle of the ordinary Plug-Cock.

THROUGH-WAY & FOUR-WAY COCKS

Of all descriptions.



PATENT RECESSED CONE CENTRE-VALVE.
Sectional Plan.


PATENT RECESSED CONE CENTRE-VALVE.
Sectional Elevation.

LONDON OFFICE: 106, CANNON STREET.

D. HULETT & CO.

Invite the attention of Gas Companies, Corporations, and others to their

PATENT STREET LAMPS,

Which are so constructed that neither putty nor other materials are required to secure the glass. No hacking out of old putty, which frequently destroys the frames. A new pane of glass can be inserted in two or three minutes by any inexperienced person, the glass being secured by a hinged flap and turn button.

PRICE 10s. each, net. Special quotations for large quantities.
Also made EXTRA STOUT recommended for its durability, PRICE 11s. 6d. each.

D. HULETT'S IMPROVED SERVICE CLEANSER,

By the use of which stoppages in service and other pipes are freed from naphthaline and other obstructions in a few minutes. PRICE 73s. net.

HULETT'S PATENT MERCURIAL REGULATOR,

For inserting in mains, to prevent the excess of pressure in high ground, or other elevated positions.

PATENTEES OF IMPROVED WET AND DRY GAS-METERS.

Makers of all kinds of Pressure-Gauges, Gaseliers, and every kind of Gas-Fittings for the Trade.

GAS HEATING AND COOKING STOVES.

55 and 56, HIGH HOLBORN, LONDON.

London: Printed by WILLIAM BOUGHTON KING (at the office of Clayton and Co. 17, Bouverie Street, Fleet Street); and published by him at No. 11, Bolt Court, Fleet Street, in the City of London.—Tuesday, Jan. 1, 1878.